BYTE

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THROUGH THE HOURGLASS

Why every kid should ha

Today, there are more Apples in schools than any other computer.

Unfortunately, there are still more kids in schools than Apples.

So innocent youngsters (like your own) may have to fend off packs of bully nerds to get some time on a computer.

Which is why it makes good sense to buy them an Apple® IIc Personal Computer of their very own.

The IIc is just like the leading computer in education, the Apple IIe. Only smaller. About the size of a three-ring notebook, to be exact.

Even the price of the IIc is small — under $1100.*

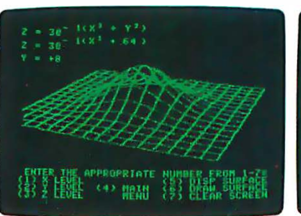
Of course, since the IIc is the legitimate offspring of the IIe, it can access the world's largest library of educational software. Everything from Stickybear Shapes™ for preschoolers to SAT test preparation programs for college hopefuls.

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Not to mention fun programs for the whole family. Like "Genetic Mapping" and







With a IIc, your kid can do something constructive after school. Like learn to write stories. Or learn to fly. Or even learn something slightly more advanced. Like multivariable calculus.

ve an Apple after school.

"Enzyme Kinetics."

And the Apple IIc comes complete with everything you need to start computing in one box.

Including a free 4-diskette course to teach you how — when your kids get tired of your questions.

An RF modulator that can turn almost any TV into a monitor.

As well as a long list of built-in features that would add about $800 to the cost of a smaller-minded computer.

128K of internal memory — twice the power of the average office computer.

A built-in disk drive that would drive up the price of a less-senior machine.

And built-in electronics for adding accessories like a printer, a modem, an AppleMouse or an extra disk drive when the time comes.



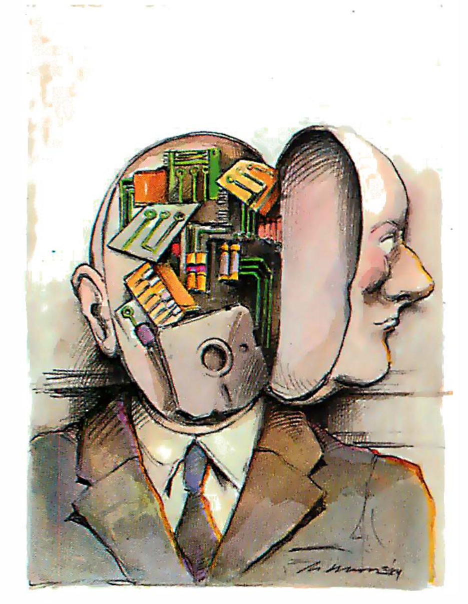
In its optional carrying case, the IIc can even run away from home.

So while your children's shoe sizes and appetites continue to grow at an alarming rate, there's one thing you know can keep up with them. Their Apple IIc.

To learn more about it, visit any authorized Apple dealer. Or talk to your own computer experts.

As soon as they get home from school.

C·O·N·T·E·N·T·S



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FEATURES

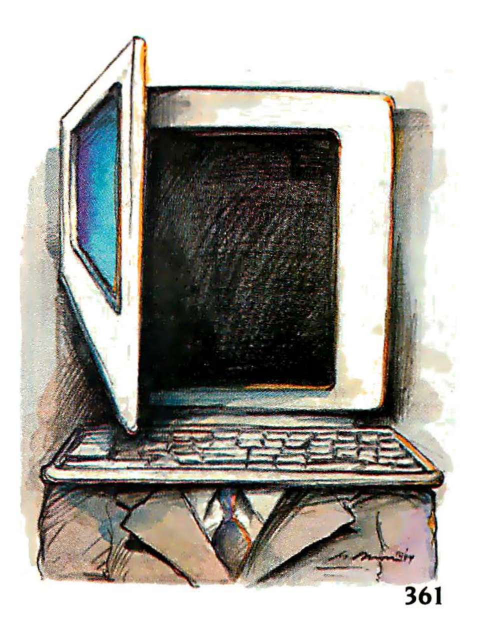
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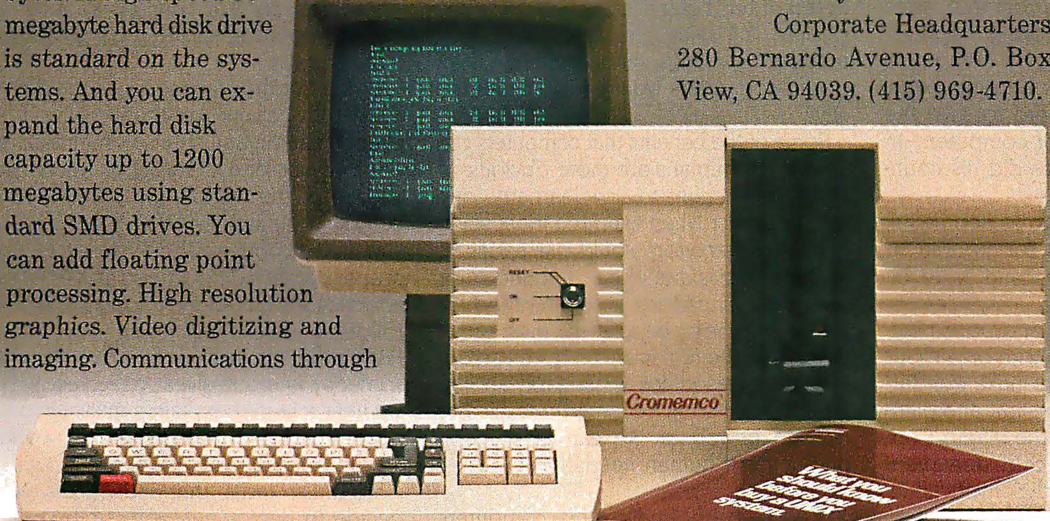
We also make our systems easier to use, because we install the operating system before we ship your computer. No complicated installation procedures. And the Berkeley enhancements give you the standard UNIX System V operating system, but with the added convenience of these widely acclaimed improvements.

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Autonomous Weapons and Human Responsibility

The human desire to avoid responsibility for difficult decisions probably goes back to the dawn of time. In their brief period on this earth, computers have taken the blame for millions of human mistakes. Who hasn't heard a computer blamed for an error in billing or delivery? One typical case of blaming the computer occurred in a school system in which a computer handled scheduling of classes. On the first day of school, the most vocal complaints came from students whose lunch hours had been assigned at 8:30, 9:30, 10:30, 2:30, and 3:30. That's right—someone had forgotten to instruct the computer that lunch has to occur in the middle of the day. The school's new computer took the blame. Those who knew little about computers hated them more over this incident. Those in positions of authority found a versatile new scapegoat.

Anecdotes like this are amusing when little hangs in the balance. In the presidential debates in the fall, however, one of the candidates suggested that military decisions affecting the fate of the earth might be irrevocably delegated to computers if the other candidate's programs were enacted. The candidate making that claim either understood nothing of computers or else he was acting as a demagogue, casting himself as the hero to save the earth from the tyranny of computers. In either case, the candidate did his country a disservice.

Computers, of course, do as people tell them. The hard part is for people to foresee all circumstances and write instructions to handle all circumstances optimally. Lack of foresight and poor planning occur in many fields with or without computers. But computers make wonderful scapegoats. When foresight and planning fail, computers take the blame. Consequently their image as cold, dehumanizing villains is perpetuated. Some fictional and cinematic depictions of computers also endow them with a villainy that exceeds the capabilities of digital electronics.

To be sure, computers are cold and indifferent. But let's consider a few cases in which the inhuman properties of computers enable them to help people. Computer conferencing enables people to exchange text messages with others who share their interests. One advantage of computer conferencing is clear: people needn't be in the same place at the same time in order to exchange comments. But computer conferencing also prevents loud and aggressive people from dominating a group as they can in face-to-face conversation. As Starre Roxanne Hiltz and Murray Turoff point out in their book *The Network Nation: Human Communication via Computer* (Reading, MA: Addison-Wesley, 1978), ". . . persons who happen to be 'fast on the draw' in a face-to-face verbal situation, and who may not be particularly intelligent or correct, tend to dominate the discussion and decision-making process in small groups." In computer conferencing, "one participant making a statement in no way interferes with the ability of another person to be making a statement that overlaps in time." Computer conferencing for the BYTE staff has led to much better discussions with much broader and more balanced participation than occurs in face-to-face staff meetings. In fact, it has been a joy to see some shy people blossom in our computer-mediated meetings. Who would have supposed computers would emancipate the shy?

Some of the benefits that computers can bestow on humans are more obvious. In giving instructions to slow learners, computers persist when even the most saintly human instructors would lose patience. In providing simulations of difficult or dangerous situations, computers reduce the risks borne by people who must sometimes face the real hazards. If we use our electronic resources reasonably, bomb disposal will soon become the exclusive domain of robots. We can make computers serve human needs.

People who understand computers understand how these machines can serve people. But some people who understand computers well are letting us fall victim once again to the myth of computers as villains. The phrase that magically shifts blame from humans to computers is "autonomous weapons." The issue skirted is the same one dealt with so poorly in the presidential debates.

We can build unmanned tanks that detect certain kinds of objects and then destroy them. We can build and program computers to monitor motion and radiation and, upon detection of patterns that we have specified, to hurl devastation on targets that we have chosen. But using the phrase "autonomous weapons" confers on such devices a higher status than that of the glorified booby traps that they are. A concealed pit of sharpened stakes is just as autonomous a weapon as an unmanned tank. A terrorist's time bomb is just as autonomous a weapon as an orbital launching pad or beam weapon. But we have no doubt that the man who digs the pit and sharpens the stakes bears responsibility for killing the man who falls in, or that the man who builds and plants the time bomb murders its victims, even if the victims are not those intended.

Humans will build the coming generation of "autonomous" weapons. Humans will program them, and humans will either make, delegate, or blunder all decisions about their control. Humans will bear all the responsibility for the good or ill these weapons do.

This is not the place to argue the merits of such weapons or the likelihood of events that might justify the manufacture, deployment, or use of such weapons. But as one of the world's most widely read computer magazines, BYTE is the place to say that computers should never be the scapegoats for difficult human decisions affecting the fate of the earth. Computers follow sequences of human instructions. People decide. If we forget this, we may someday find ourselves speechless when we hear a leader explain a missing continent by saying, "The autonomous weapon was in a loop."

We must insist that individuals who decide to deploy autonomous weapons bear responsibility for everything these weapons do.

—Phil Lemmons, Editor in Chief

the closest thing to perfect is *WordPerfect* by SSI.

Reference Magazine

When it comes to software, nobody's perfect. But according to many of the experts, one word processing program is as close as you can get. No wonder it's called WordPerfect.

What are all the critics raving about?

Simplicity. Most WordPerfect functions require only one keystroke, a simple press of a finger. So you can concentrate on writing, not programming.

Speed. Because it is document-oriented instead of page-oriented, WordPerfect won't make you wait between pages. No matter how fast you type, WordPerfect won't slow you down.

WordPerfect isn't flawless word processing software, but it comes very close.

Digital Review

WordPerfect is my favorite because it is easy, simple and powerful. The people

List Magazine

Features. From writers to doctors, accountants to lawyers, WordPerfect has built-in special functions to meet a wide variety of specific needs. And at SSI, every day is spent upgrading and improving WordPerfect — reaching for perfection.

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But it's not just the Chameleon's similarities to the IBM that should interest you. Its advantages should, too. The Chameleon also has an 8 bit microprocessor that lets you run any of the thousands of CP/M-80® programs available. It comes complete with two of the best programs around, Perfect Writer™ and Perfect Calc.™ It's portable. And you can plug it in and start computing the moment you unwrap it.

So if you've been interested in an IBM personal computer, now you know where you can get one for $1595. Wherever they sell Chameleons.

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Chameleon shown with optional second disk drive.

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Staff-written highlights of late developments in the microcomputer industry.

Optical Disks Move Toward Reality

Information Storage Inc., Colorado Springs, CO, expects to provide samples of its 525 WC optical-disk drive (write-once, read-often) in April, with full production later this year. The drive uses removable 100-megabyte 5¼-inch disk cartridges. ISI hopes to eventually sell the optical-disk drive to computer makers for about $600 and the disks for about $40 each. Initial prices will be much higher.

Compact Discs as Read-Only Memory for PCs

At the fall COMDEX show in Las Vegas, several companies announced products using a standard compact disc (CD) as a read-only-memory device for computers. Each CD ROM can store up to 550 megabytes of data (about 275,000 pages of text) using the same 4.72-inch disc format used in CD digital audio recordings. Philips Subsystems and Peripherals Inc., Hitachi America Ltd., Sony, and Denon America Inc. all announced or showed CD ROM drives at COMDEX. Earlier, 3M announced that it will produce discs for use in CD ROM drives. Sony and Denon both expect to sell drives to computer makers for less than $300; with a controller, a CD ROM should retail for substantially less than $1000.

New Chips Will Find Uses in Image Processing

NEC Electronics announced the μPD7281D, which it says is the first non–von Neumann single-chip image processor. The 7281 executes as many as 5 million instructions per second. Linking multiple 7281s further increases processing speeds. The chip can also be used for signal processing and mathematical calculations. NEC plans to produce samples of the chip late this year.

NCR announced the Geometric Arithmetic Parallel Processor (GAPP), developed jointly with Martin Marietta Aerospace. The GAPP includes a 6 by 12 array of 1-bit processor elements, each having 128 bits of RAM. Many GAPP chips can be cascaded for use in image processing. NCR suggests that robot vision, image compression and enhancement, digital signal processing, and arithmetic array processing are possible applications. NCR is selling samples of the NCR45CG72 GAPP for $545.

Portable Computers Feature 80 by 25 Displays

Mitsubishi's Tredia notebook computer includes an 80-line by 25-character LCD, 64K bytes of RAM, a Z80A processor, a microcassette drive, a 300-bps modem, serial and parallel ports, a bar-code-reader port, and a ROM cartridge slot. A 64K-byte ROM includes a spreadsheet, database, graphics, word processing, and communications software. Internal nicad batteries allow use of the machine for up to 8 hours. The $1200 Tredia weighs 6.6 pounds and measures 11¾ by 8½ by 3½ inches.

Quadram announced DataVue, a 14-pound portable computer with an infrared keyboard link. The $2195 system includes 128K bytes of RAM, one 5¼-inch disk drive, an 8088 processor, parallel and serial ports, a pivoting 80 by 25 LCD, an AC adapter, and batteries that will last about 1½ hours. It will be available in March.

Display Technology

Sony announced a new multicolor display technology called Currentron. The monitor alters the shade and color displayed by changing the beam current. Resulting colors include red, orange, yellow, and yellowish-green. Two versions will be available as engineering samples: one displays 900 by 200 pixels, and the other, 1100 by 864 dots. Monitors using the Currentron technology should be sharper but less expensive than full-color monitors.

(continued)

COMDEX: New 2400-bps Modems

Several companies introduced 2400-bps modems at the COMDEX show in Las Vegas. Most of the modems are compatible with the Bell 212A standard at 1200 bps, the Bell 103 standard at 300 bps, and the CCITT V.22bis standard at 2400 bps. Most also include auto-dial capabilities, some phone-number memory, and claim some degree of compatibility with Hayes "AT" modem commands. Some of the modems are stand-alone units; others are IBM PC expansion cards. Two use front-panel LCDs instead of the usual LEDs: Penril DataComm's $895 Datalinx Model 224 and Novation's $795 Professional 2400. Telenetics, Multi-Tech Systems, and Cermetek announced $795 modems; U.S. Robotics chose an $895 list price. Neither NEC America nor Microcom had set pricing for their 2400-bps modems.

Team Technology, Taiwan, introduced a line of low-cost modems, available through Chen Manufacturing, Alhambra, CA. The SmarTEAM 2400 features 2400-, 1200-, 600-, and 0–300-bps capabilities for $450; no availability date was set. The $159 SmarTEAM 103/212A is a 1200- and 0–300-bps modem. Team's ModemPhone 300 is a $37 300-bps modem.

Users May Find Surprises in Apple Insurance

Apple has endorsed a computer insurance policy offered by Emett & Chandler Inc., but neither Apple's letter nor the enclosed brochure explained that only one computer could be covered under a single policy. Since the application didn't require purchasers to list what non-Apple equipment they had—only its dollar value—some owners may not realize their non-Apple computers aren't covered.

NANOBYTES

Volition Systems, Del Mar, CA, is now shipping its $295 Modula-2 compiler for the Macintosh. . . . **Living Videotext**, Mountain View, CA, announced a $245 version of ThinkTank for the 512K-byte Macintosh. . . . **Advanced Micro Devices** introduced the Am29300 32-bit bipolar microprocessor family. Included are a 32-bit parallel multiplier, a floating-point processor, a microprogram sequencer, and an ALU. . . . **Digital Research Japan** will adapt CP/M, CP/M-86, Concurrent DOS, and other system software to run on **NEC**'s recently announced V series of 16-bit CMOS microprocessors. . . . **Sinclair Research** is developing a wafer-scale 512K-byte memory device. . . . **TT&T Corp.**, Hampton, NH, announced NH-Ada, a $225 subset Ada compiler for the IBM PC. . . . **AT&T** has published the "System V Interface Definition," which defines a minimum set of system calls and library routines that should be included in all operating systems based on its UNIX System V. . . . **Microsoft** is shipping Microsoft Networks 1.0 and MS-DOS 3.1, both of which add network capabilities to MS-DOS. . . . The **FCC** has authorized use of the TV vertical blanking interval for data transmission, which could mean software delivery by TV. The FCC had earlier cleared the way for broadcast of software over radio. . . . **Versatron Research**, Healdsburg, CA, introduced the $225 Footmouse, used to control cursor keys. . . . **Lotus Development** formally announced Jazz, its long-expected Macintosh product. The $595 program includes word-processing, spreadsheet, database, communications, and graphics functions but requires a 512K-byte Mac. Lotus also announced spelling-checker and text-outlining add-on products for Symphony. . . . **Tomcat Computer**, Los Angeles, CA, announced the Tomcat 3200-AT, which includes an 80286 processor, IBM PC AT-compatible expansion slots, 640K bytes of memory, one 1.2-megabyte floppy disk, a 20-megabyte hard disk, serial and parallel ports, and a color graphics card for $4529. . . . **Maxell** is ready to produce 5¼-inch floppy disks with a capacity of 6.5 megabytes for use in drives made by its parent company, Hitachi. Maxell showed two metal floppy disks: a 10-megabyte 5¼-inch disk and a 5-megabyte 3½-inch disk. Maxell also showed a 5¼-inch optical disk that stores 250 megabytes per side. . . . **Transtec Technology**, Dublin, Ireland, announced its Hydra PC, featuring 800- by 512-pixel graphics in four colors or, optionally, 16- or 4-color graphics with a resolution of 1024 by 1024 pixels. With a 1.2-megabyte floppy disk, a 10-megabyte hard disk, and 512K bytes of memory, the Hydra PC will cost $4900.

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Auto-Logon. Lets you log on to a host simply and quickly by utilizing prompts and responses defined by you. Also allows quick transmission of predefined responses to host application programs after logging on.

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Full Printer Support. Printer buffer automatically buffers characters until printer can process; automatically stops on-line transmission when full; and automatically resumes transmission when capacity is re-established. Also, lets you print contents of textual video screen or RAM buffer at any time.

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QXDraw

In reference to the letter "A Call for QX-10 Support" in the August 1984 issue (page 23)—there is at least one inexpensive program that is semi-educational for the Epson QX-10.

The program I am talking about is QXDraw. It is available through your local Epson dealer or directly from American Small Business Computers.

QXDraw is a graphics design tool that uses the graphics capabilities of the Epson QX-10. It allows someone unfamiliar with computers to design and draw figures, charts, schematics, or blueprints in no time. QXDraw has the capability to store, retrieve, and print figures drawn on the screen. In addition, it can fully manipulate figures and text by changing size, angles, and dimensions.

PAULA MIBB
American Small Business Computers
Pryor, OK

Benchmarking UNIX Systems

I have been using the UNIX operating system on various machines for several years. I am happy to see it gaining popularity in the microcomputer world. I enjoy reading the articles in your magazine on the C programming language and on anything dealing with UNIX, and I hope to see more in the future.

I found the article "Benchmarking UNIX Systems" by David F. Hinnant (August 1984, page 132) interesting and informative. However, I would like to bring to your attention a few errors I found in that article.

In the first benchmark (listing 1), the parent process should issue a wait system call after closing the pipe to wait for the child process to complete for two reasons. First, if the parent process terminates without waiting for the child process to complete, the reported elapsed (real) time may be too small, since the child process may continue reading from the pipe for a while after the parent has terminated. Second, unless the parent process issues the wait system call, the user and system times reported will be those of only the parent process, rather than the sums of both processes.

In the results of the multitasking UNIX benchmark (table 3 and figure 1), the indicated number of concurrent processes is misleading. This number is actually the number of shell processes concurrently running tst.sh. Each of these shells may have up to three child processes running concurrently (when executing the pipleline containing grep, tee, and wc). The user performing the benchmark has three additional processes: the shell running multi.sh, the time utility, and the shell interpreting commands from the user's terminal. In addition to this, there are at least three background processes: the swapper, init (the system initializer), and update. Thus, it is not surprising that some microcomputer implementations of UNIX were not able to concurrently run tst.sh more than three times. This would have resulted in a total of 12 to 18 processes, depending on how many active child processes each tst.sh had. Note that the limiting factor here was probably the size of the system's process table and not an arbitrary limit of processes per user, as Mr. Hinnant suggests.

GILBERT DETILLIEUX
Winnipeg, Manitoba, Canada

Mr. Detillieux's letter brought to my attention a typographical error I had not caught. When developing the benchmark programs, I used two sources for each benchmark; one with comments and one without. This was because I usually had to enter (or have someone else enter) the benchmark sources by hand, and an uncommented source listing is much easier to read. Unfortunately, the line

```
wait((int *)0);
```

must have been inadvertently deleted from the commented version of the sources that I furnished to BYTE in machine-readable form. That line should appear immediately after the line

```
printf("Error in parent closing \ n");
```

I regret the error and thank Mr. Detillieux for bringing it to my attention.

The second point Mr. Detillieux raises deserves some discussion. Upon reflection, perhaps a better label for columns 1 through 6 would be "Number of Background Submissions." However, I still contend that the inability of some of the microcomputer systems to complete the benchmarks is the per-user process limit. One would expect the process table size to be at least as large as the per-user process limit because even on single-user systems there is commonly more than one user. Consider the "root"-owned programs like update, cron, swapper, *and* init. *Also, UNIX UUCP communications programs typically run under their own user ID. You would expect the implementation to take this into account and to provide enough process table slots for all possible normal background processes as well as enough for every "real" user.*

DAVID HINNANT
Raleigh, NC

On FORTH

I believe the FORTH standards committee has a death wish because it continues to create new dialects with each "standard" it creates. I am concerned that readers will be turned off by FORTH when they read "FORTH-83: Evolution Continues" by C. Kevin McCabe (August 1984, page 137). A careful reader will realize that FORTH-83 is more revolution than evolution from FORTH-79.

If the FORTH standards committee used new names, new dialects would not have to be created. For example, the FORTH-83 DO LOOP and DO +LOOP are very dif-

(continued)

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ferent from the FORTH-78 DO LOOP and DO +LOOP. I would like to use both versions of FORTH and I would be able to if the FORTH-83 commands were DO83, LOOP83, and +LOOP83. More important, I would use the new keywords only when their new properties are relevant and I would continue to use the proven FORTH-78 keywords as before. In this way evolution can take place with a minimum of risk. (Note my use of FORTH-78; the FORTH-79 standard is incomplete and thus useless to me.)

As an experienced FORTH programmer, I find the changes from FORTH-78 listed in table 3 (on page 412) to be marginal and mostly unnecessary. For example, having / and /MOD leave floored quotients is a plus, but the FORTH-78 names create a dialect. The plus is overwhelmed by the dialect minus. If the standards committee had used the names /83 and /MOD83, you would be able to use all of the keywords without any dialect. Furthermore, implementations of the new keywords have not yet been fully evaluated; their practical consequences are not known.

I think the new definitions in FORTH-83 are not significant improvements over the old ones—additions to FORTH-78 would have made more sense.

I suggest that the FORTH standards committee address new areas such as graphics, mathematics, and databases in lieu of massaging yesterday to death.

NICHOLAS L. PAPPAS, PH.D.
Oakland, CA

ALTERNATIVES TO IN-SEARCH

As an information broker and consultant with 10 years of experience in searching various on-line information-retrieval systems, including Dialog, I would like to comment on the July BYTE West Coast, "Trends in Telecommunications" by John Markoff (page 341), especially the section subtitled "In-Search" (page 342).

In-Search purports to make it easier for both the novice and the experienced user of Dialog to interact with the system, but does it? On examination of the package it appeared to me that the introduction of this intermediary to the Dialog system would at most save the user only seconds of on-line connect time. The $399 that In-Search costs could be better spent on some other options available; for example, the Online Teaching and Practice

(continued)

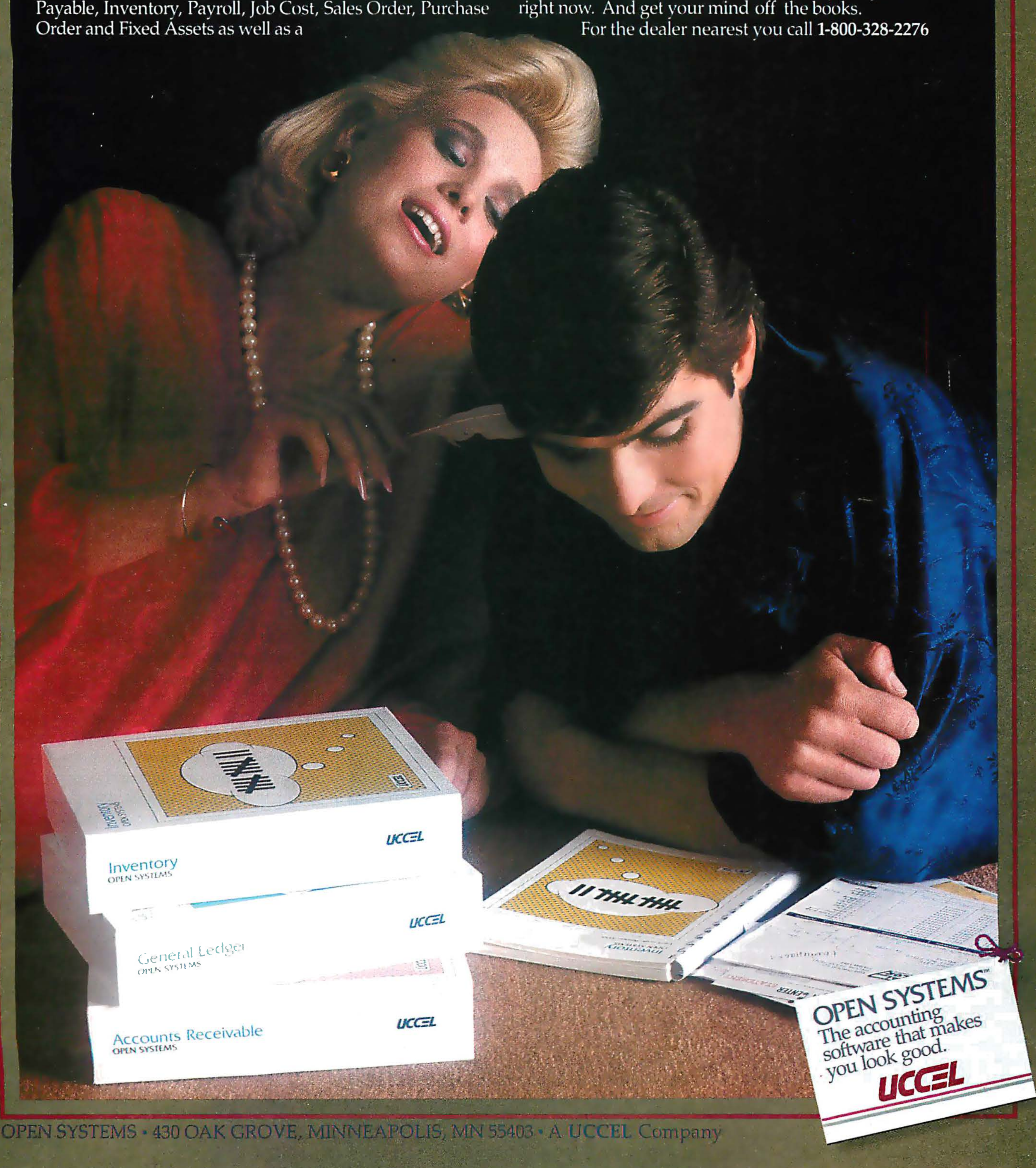
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LETTERS

(ONTAP) files. These are subsections of several files available for $15 per connect hour, plus less than $10 per connect hour for telecommunications charges. Another option, popular with personal computer users, is a subscription to Knowledge Index, a subset of the complete Dialog files, available after 6 p.m. on weekdays and on weekends for $24 per hour, all inclusive.

Therefore, for the price of the In-Search package, you can have about 15 hours of search time. Since a typical search should take less than 10 minutes, this translates into a lot of searches. As well, to use the In-Search package you have to learn more key functions and commands, all of which are no less complicated than the few Dialog commands you have to learn to use the database. With or without the In-Search package you still must learn and understand the concepts of Boolean logic and search building.

One of the beauties of Dialog is that it is available throughout the world for a good portion of each week. Once you have learned some simple commands and concepts, made more mnemonic and user friendly in Knowledge Index, you can search the system wherever you happen to be and with whatever equipment is available. How unfortunate then, to introduce the In-Search crutch if you cannot operate Dialog without it.

In addition, there are other telecommunications software packages that are cheaper and are not tied to a particular information-retrieval system but that, nevertheless, allow downloading and editing of results.

In conclusion, I believe that this package is indeed an example of patronizing the naive user and never giving him a chance to grow up. Currently In-Search and similar tools are being reviewed by several publications. It is evident from reading these reviews that the reviewers have been unable to intensively test and evaluate the products. I would suggest that balanced reviews can only be carried out by information professionals who know what to look for.

MARY M. NASH
Ottawa, Ontario, Canada

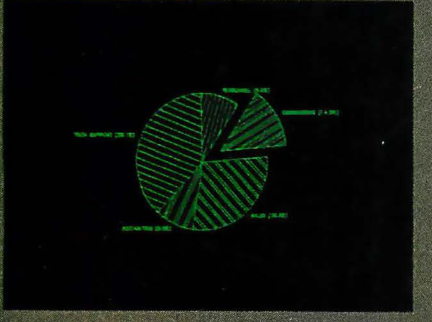
BASIC09

Wendell Brown's desire for a well-structured BASIC that runs on the Apple II (July 1984 Letters, page 16) would probably be

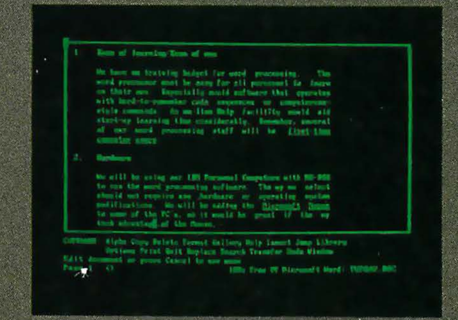
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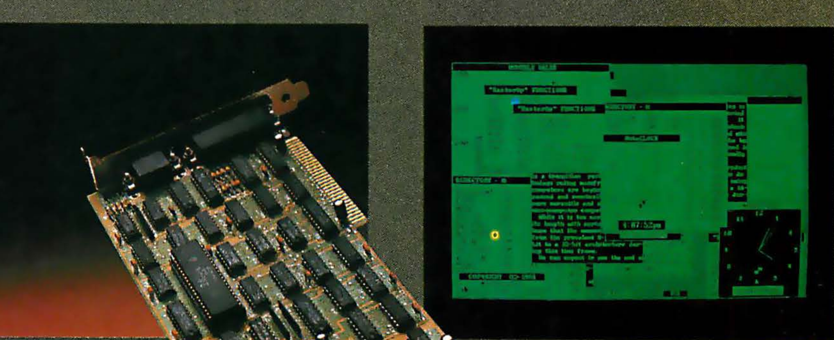
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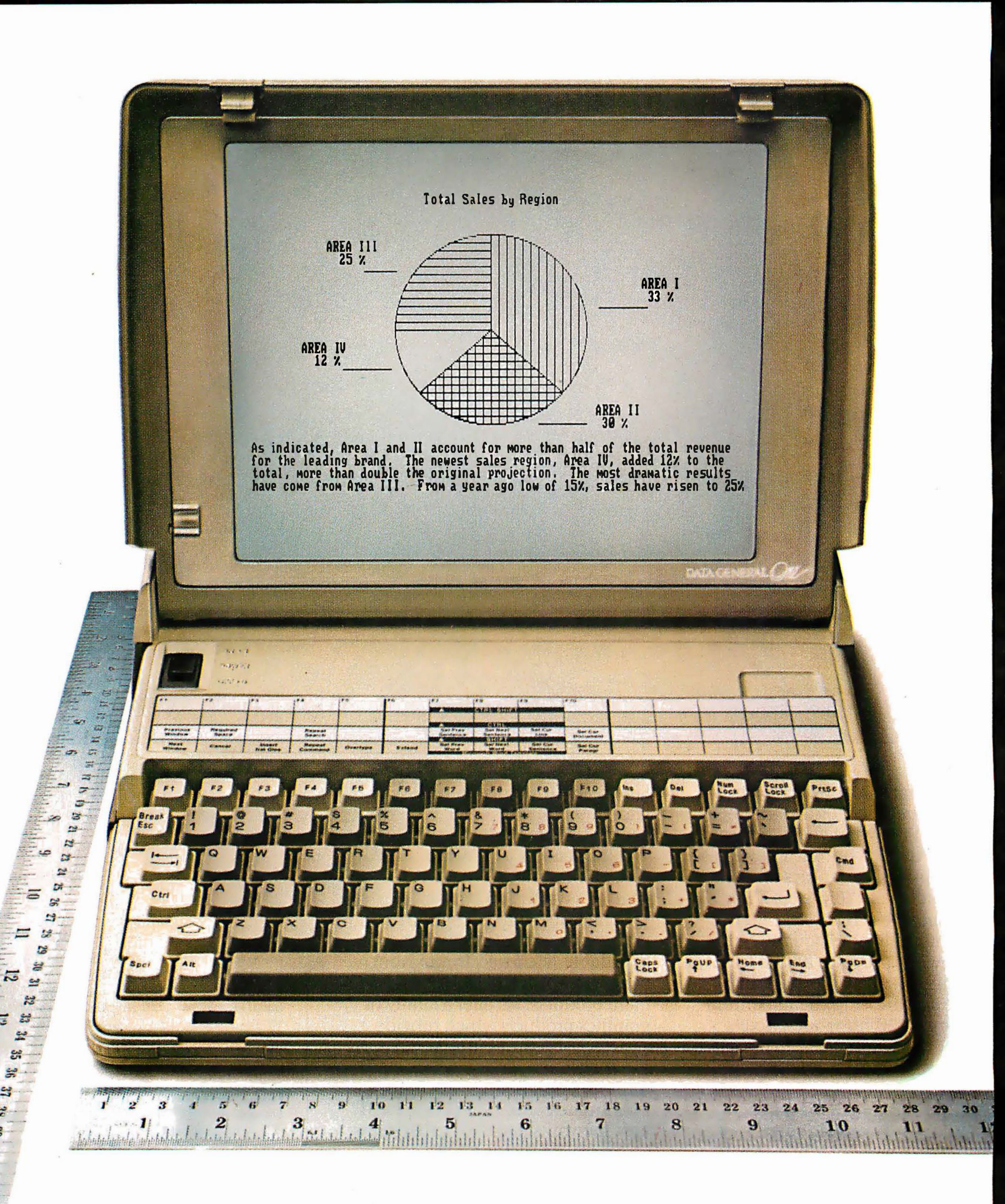
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satisifed by BASIC09, which runs under the OS9 operating system and therefore requires a 6809 card. The card and software are available from: Stellation Two, POB 2342, Santa Barbara, CA 93120.

BASIC09 features IF. . .THEN . . .(ELSE) . . .ENDIF, REPEAT. . .UNTIL, WHILE . . . DO. . .ENDWHILE, LOOP. . .ENDLOOP, EXITIF. . .THEN. . .ENDEXIT, and FOR . . .TO. . .(STEP). . .NEXT control structures. IF. . .THEN. . . ELSE statements can be nested. The language compiles to an intermediate code, which is then interpreted, and, unlike CBASIC, the compiler/decompiler is interactive and flags most errors immediately.

Stellation Two provides excellent support and has a reasonable update policy.

F. KUECHMANN
Vancouver, WA

MODULA-2: TWO DISSENTING VIEWS

David B. Moffat's "UCSD Pascal vs. Modula-2: A Dissenting View" (August 1984, page 428) was a pleasure to read—a sort of the-emperor-isn't-wearing-any-clothes type of critique. I agree with Mr. Moffat's objections to separate input/output statements for every variable type and to the case sensitivity of the language. The language has one other feature that in my opinion is a nuisance—the required use of IMPORT statements to specify the libraries in which modules exist. Not only do you have to know the names, purposes, and acceptable arguments of procedures that are usually considered "standard," but you also have to know where those modules are located in order to be able to call them into a program. This is the sort of bookkeeping task that higher-level languages were invented to avoid.

As an application programmer I fail to see how Modula-2 is an advance in meeting my programming needs. I am far happier with Turbo Pascal, which lets me set up libraries (though not precompiled) that are easily called into programs with an INCLUDE compiler command.

Turbo Pascal is case-insensitive and provides convenient low-level capabilities for bit manipulation and direct access to memory and MS-DOS interrupts.

Perhaps systems programmers, for whom Modula-2 was developed, can appreciate the virtues of that language—but I do not think that Modula-2 is a superior applications language. Every time I read one of Jerry Pournelle's glowing comments about Modula-2, I react with the question: But has he tried programming in that language?

JOHN FIGUERAS
Victor, NY

After reading the articles concerning Modula-2 in the August 1984 BYTE, I feel compelled to comment. On the whole, I thought the articles were well written and gave a good overview of the language. However, I believe that I detected a certain amount of chauvinism on the part of those committed to Modula-2, and it is this point I would like to address.

Engineers have a tendency to fall in love with certain designs, and software engineers are no exception. We put so much time and energy into the designs we work with that it is as if we become married to them and can no longer look at them with objectivity. I know I have been guilty of this on many occasions, and I am sure that others can recognize this capacity in themselves. However, as software engineers we have an obligation to be objective when considering designs and to address any legitimate concerns that are raised.

Currently we are confronted with debate between the proponents of both Modula-2 and Ada. Being in the Ada camp, I would like to have the Modula-2 devotees address my legitimate concerns regarding this language. All too often the debate degenerates to nit-picking about this or that feature of Ada being clumsy or inefficient or not theoretically pure enough. I can play this game as well as the next engineer, but I won't because I feel that this only results in the chauvinism I speak of. My single largest concern is one I feel is carefully avoided in debates of this nature, and it desperately needs to be addressed in an objective manner by anyone advocating the use of a new language.

Ada, as a language, has one great advantage over all others. It is rigidly standardized and the standard can be effectively enforced. While it may have many serious drawbacks, which opponents are quick to point out, lack of standardization is not one of them. Even a poor standard, enforced by the entire might of the Department of Defense, is infinitely superior to no standard at all. My question to the Modula-2 people is how do they propose to ensure that a software commitment on one machine using one compiler can be salvaged when migrating to another machine with a different compiler? An ANSI standard alone, should one be produced, is not always enough.

I own a company that has committed itself to software development in Ada. We believe that our success will hinge on our ability to generate software that is reliable, reusable, and above all else, transportable. Reliability is dependent only on our abilities as software engineers and the quality of the tools we select. Reusability is provided in both Modula-2 and Ada through their ability to generate libraries of general-purpose utility routines. However, only Ada provides a language reference manual so precise and detailed that it has spawned a new generation of "language lawyers," a trademarked name that guarantees the DOD the ability to enforce the standards laid down in this manual, and a validation procedure that will test every Ada compiler against the standard before it can bear the name. What does Modula-2 offer me in this respect as a businessman to justify a software commitment to this language?

Ada has some flaws: complexity, lack of certain theoretical advantages, the massive size of its associated compilers, and others. But because we have an effective standard to work with, I feel that we can produce software at a lower cost to our clients. The logic is simple: if we stay within the standard, and if our clients have a validated Ada compiler, any software written on our system should run on their system. We spend less time making patchwork fixes and adjustments, and we can bring in software tools developed on other projects without fear of needing to modify the tools.

Modula-2 is a good language. It incorporates some of the best developments in the field of theoretical computer science to come along in recent years. However, I think that it will have some serious problems in the future if the question of portability and standardization is not addressed quickly.

MARIN D. CONDIC, PRESIDENT
Modular Systems Research
Kalamazoo, MI

CALTECH'S COMPUTER NETWORK

The article "A Computer on Every Desk" by Donna Osgood (June 1984, page 162) was interesting but failed to mention the educational computing activities at the California Institute of Technology (Caltech). I feel our program has several unique features. A fully functioning campus-wide network links all our computers. The network was completed this summer by a team of Caltech students that installed

outlets in the dormitories. The following description of our program is excerpted from the June 1984 edition of *Caltech News*.

Caltech has received major grants from IBM and from Hewlett-Packard to support its educational computing project.

From IBM, Caltech will receive several hundred IBM Personal Computer workstations, a hostprocessor, several graphics subsystems, and technical support, all to be used in the development of educational software.

From Hewlett-Packard, Caltech will be recipient of 22 color desktop computers and support equipment for an introductory computing course, an introductory solid-state electronics course, and a solid-state electronics laboratory. In the first course, freshmen will use the Hewlett-Packard computers to learn programming, and in the last two, undergraduates will use the computers to design electronic devices. The equipment is worth $528,694.

Along with the IBM equipment will come a cash grant of $150,000 to purchase adapter cards to tie the IBM workstations to Caltech's campus-wide high-speed computer network. IBM has also assigned a technical support person to the project during the three years that the company is involved. . . .

When it is fully implemented over the next three years. . . . [the] Caltech educational computing project will include more than 800 workstations. Linked by the campus computer network, they will be grouped in clusters of up to 10 or 20 machines in classroom areas, laboratories, the computing center, and libraries.

Faculty and teaching assistants will have individual workstations to prepare courseware. Students will have network outlets in their dormitories, enabling them to communicate with the campus system, using their personal computers. All the individual units will be tied to campus mainframe computers. . . .

The Caltech project is aimed primarily at developing courseware for all the disciplines at the Institute. Educators will emphasize creation of specialized graphics software that will enable students to "see" abstract concepts in visual terms. . . .

Besides IBM and Hewlett-Packard, other manufacturers contributing to the project include Data General, Digital Equipment Corporation, Evans & Sutherland, and Tektronix.

HOWARD RUMSEY JR., PH.D.
California Institute of Technology
Pasadena, CA

SCOUT

I would like to tell BYTE readers about an IBM PC XT product that has saved me a great deal of time, money, and frustration

(continued)

over the past four months. Scout, a Computer Insights product, provides a set of functions that greatly enhance those provided by DOS 2.X for using subdirectories.

Scout allows you to define "imaginary drives." These drives model DOS 1.X disk directories and allow programs that do not understand DOS 2.X paths to access files in subdirectories. This makes many older programs usable and will save you money by eliminating the need to buy new DOS 2.X versions. The "imaginary drives" can be defined as read-only and provide protection of valuable data. Scout can be used to prevent catastrophes such as your accidentally formatting your hard disk.

Although these capabilities are useful, Scout's greatest asset is its ability to search subdirectories for data, profile, help, overlay, etc., files in a manner similar to, but more flexible than, the DOS 2.X PATH command. This saves a great deal of disk space because it lets you maintain only one copy of files used by programs run in many different subdirectories.

I have yet to find a bug in Scout. I recommend this product to anyone who uses DOS 2.X, especially if you think subdirectories are a good idea and ought to be more useful than they currently are.

If you're interested, you can obtain Scout from Computer Insights, POB 110097, Pittsburgh, PA 15232.

PAUL CRUMLEY
Monroeville, PA

"GOOD-BYE, TEACHER . . ." EXPLAINED

Stephan L. Chorover recently referred to me in "Cautions on Computers in Education" (June 1984, page 223) as

> . . .a behavioristically inclined psychologist who was one of the leading developers of an earlier system of automated instruction inspired by the work of B. F. Skinner. The so-called "Keller Plan" is one of the old theories that has died along with many other well-intended measures for increasing educational productivity through automation.

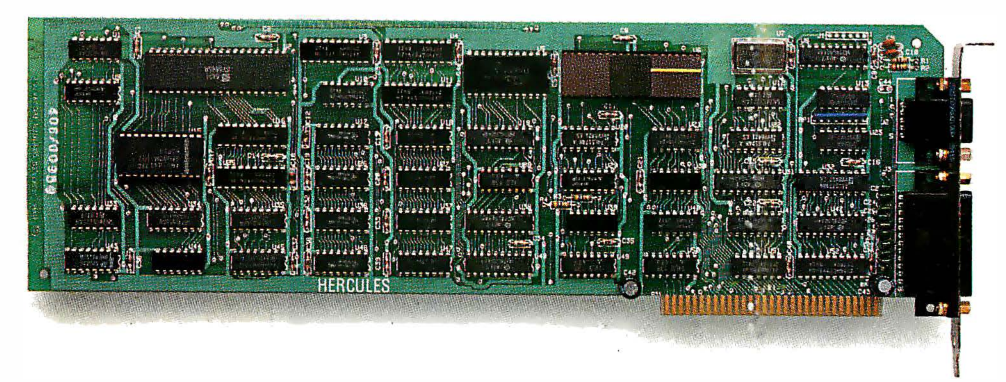
In the interest of veracity it should be noted that personalized instruction, to which Mr. Chorover refers, is not a theory, but a teaching method; the method is alive and well and is a frequently used alternative to the group-instruction-by-lecture method; personalized instruction has nothing whatever to do with automation (as Mr. Chorover would know if he had read the paper "Good-bye, Teacher. . ." to which he makes a reference); and it was inspired by, but not modeled after, B. F. Skinner's work on individualized instruction, for which we were all grateful. I am not just "behavioristically inclined," I am a behaviorist and have been one for more than 50 years.

FRED S. KELLER
Chapel Hill, NC

ONE READER'S "PERFECT" MICROCOMPUTER

In regard to Richard Knop's concept of the perfect microcomputer (July 1984 Letters, page 26): The Olivetti M-20 computer uses the Z8000 microprocessor and meets

(continued)



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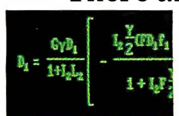
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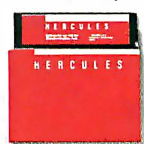
essors that can produce publication quality documents with mathematical formulas.

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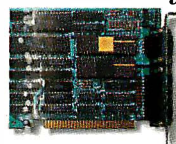
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most of Mr. Knop's other requirements.

I had come to the conclusion that since the IBM does not use the Zilog 8000 or the Motorola MC68000, computers with these microprocessors must not exist; one certainly cannot find articles in BYTE indicating that there are software programs that are compatible with the 8000.

It is frustrating, to say the least, to always have to contact Olivetti to learn of programs I can use with the Z8000.

C. L. NORRIS
West Palm Beach, FL

ICONS VERSUS COMMANDS

In the 1960s it was batch processing, and I felt so modern sitting at a card punch. Around 1970, a number of batch systems introduced timesharing "options," and I signed up for a terminal days in advance. (For a number of years I clung to my card decks as a backup; then they were phased out.) In the mid-1970s, minicomputers were the rage, and operating systems came out that were designed from the start to be conversational: henceforth I never wanted to return to the data-entry kind of system. Around 1980, microcomputers became powerful enough to be useful, and the cathode-ray tube has become a fact of life.

Now the issue is icons versus commands, a trend that BYTE apparently has not caught on to.

I assert that icons are an advance over command-driven systems comparable to the advance from cards to the cathode-ray tube. It is not simply a matter of adding a new capability to an old design: after being introduced to icons (you guessed it: I now own a Macintosh), I am still curious to see what wonderful software is available on other systems, but I find that I have lost the patience to plow through a manual and gobble up the keywords, the syntax, the options, and the modes. Today I want it in dynamic pictures or not at all, and I don't want to have set up statements underneath, like punched cards in a drawer.

FRANCISCO JOSÉ OYARZUN
Los Angeles, CA

MORE MAC FEEDBACK

Two letters in BYTE have caused me to take word processor in hand. The first letter was from Robert Lurie ("More Mac Reactions" May 1984, page 16) concern-

(continued)

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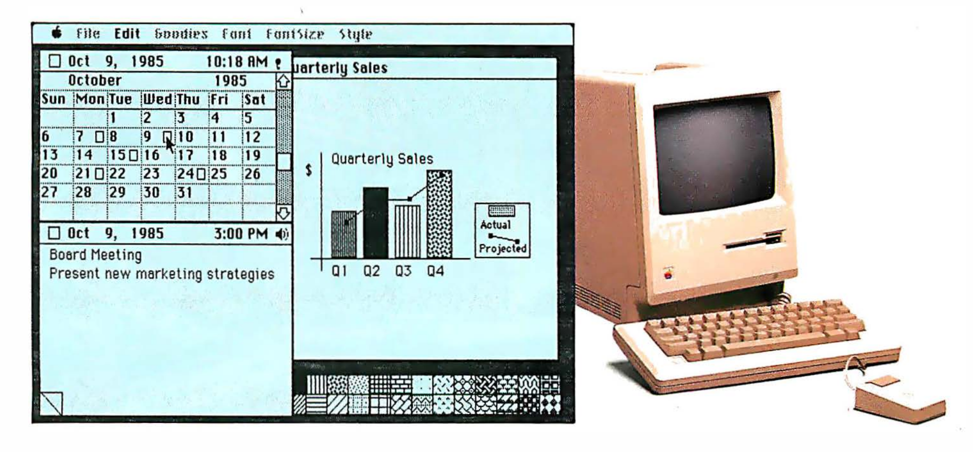
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LETTERS

ing Apple's not putting the floating-point software in the Mac's ROM. He mentioned that Apple programmers had exhausted their ROM space, so they moved the software to RAM. How can you exhaust ROM space unless you have reached the central processor's memory-addressing limits? The answer is: you cannot. In this case, they hadn't run out of ROM space—the fact that a 512K-byte RAM Mac is possible refutes that remark. You have to freeze the ROM at a point sometime, however, and possibly the company forgot to add the floating-point software before it froze the final version of the ROM at 64K bytes, so they put it in RAM. I have to agree with him, though; if the floating-point will run 25 percent slower out of RAM than ROM, then Apple's programmers did make a design mistake. It may be too late to do anything about it, though, because too many Macs have been distributed to change the situation.

The second letter I want to comment on was from David Nibbelin in the June 1984 issue ("American as Apple Pie," page 14). I have seen patriotism before, but this is ridiculous. I cannot understand why he is so angry that the Mac uses a Sony disk drive. If Mr. Nibbelin hasn't noticed, the computer revolution is not just happening in the United States but all over the world, and if advanced computers are to be built, technology must be used from wherever it is found. If he is really against non-American technology, then he will also boycott the Radio Shack Model 100, the AT&T PC, and almost any computer that uses 256K-byte RAM chips (a great deal of which are made in Japan). A person interested in the computer industry cannot shut out a nation like Japan, which has so much to offer us and the industry. To restate and add to a quote by Mr. Nibbelin: I hope the rest of the computer-buying public will recognize this un-American approach and express their reaction at the computer-store purchase counter, showing that they are not swayed by where a product is from—rather, by what substance it is made of.

DAVID ZIMMERMAN
Elizabeth, NJ

I am a software engineer at a major defense corporation. Most of my work is done on Digital Equipment Corporation (DEC) super-minicomputers, although I also work with military processors and a number of different desktop computers such as the IBM PC and the DEC Pro 350. I also own an Apple Macintosh, the cute

(continued)

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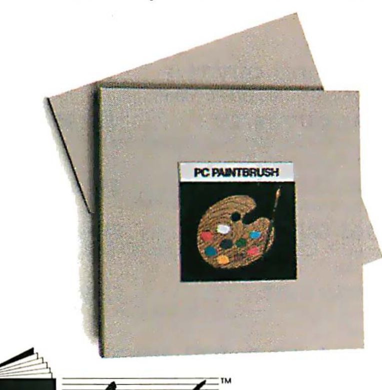
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little machine everyone is so curious about—the one without any documentation or software.

I must admit, Jerry Pournelle hit the nail on the head when he said that many of us who no longer consider ourselves "the rest of us" have been attracted to this little imp. Certainly the Macintosh is the closest thing to a Xerox Star workstation that one might hope to have on one's desk at home. Oh sure, it could have been cheaper, and it could use more memory. And it obviously could use some more software. But all these criticisms aside, one must admit that it is without a doubt one of the most innovative personal computers ever introduced. It also has great mass appeal because it's the first personal computer that's both fun and easy to use.

Personally, I don't feel the least bit insulted using a computer that represents information with pictures. Rather, I am intrigued by these uncommon techniques. The concepts alone merit one's attention whether they are the way of the future or not. Witness however, DEC's latest product announcement, the VAXstation 100 workstation, with its bit-mapped graphics, multiple windows, pop-up menus, use of icons, and even a mouse.

The Macintosh presents a whole new set of concepts to the personal computer user in its man-machine interface. It is a computer that people want to try. It is a desktop productivity tool that anyone can use. I won't argue that without application software there is not much you can do with it. But software will come. There is always a learning curve associated with doing something completely new, so it may take a little longer to develop Macintosh software than if you were simply porting software to yet another IBM semicompatible.

I believe, however, that Apple may have one problem with this wonderful machine—Apple's image. Apple's designers have always enjoyed the image as the wonder boys of the personal computer industry, and this is true now more than ever. However, this image will make it difficult for Apple and others to convince the corporate powers of many large and conservative companies that the Apple Macintosh is the desktop computer their employees really need. After all, the "three-letter" machines they now have on their desks have been quite an improvement over nothing at all.

If I can find any fault with Apple, I must say that I don't believe they are giving the "basement programmer" enough support. Surely they are in need of application software for this new product. Yet by relying only on the proven vendors, I feel they are ignoring the history of the personal computer software industry. Many of the software vendors Apple now considers a good risk started in their basements with just a computer and a unique idea. Also, it seems that most small software companies are good for only one or two really innovative products.

I don't fault Apple in its goal of securing a solid base of established software products for the Macintosh. This is critical to the Mac's success. However, Apple and the rest of the personal computer industry must not forget the yet-unknown software designers, as these people, unpressured to produce new products, will continue to be key innovators in the industry.

T. M. Nicholson
St. Louis, MO ■

FEEDBACK

Solution Doesn't Wash

T. J. Higgins felt that he could improve upon Martin Janzen's solution to the difficulties that pop up when disabling/enabling interrupts during critical sections of code on the early versions of the IBM PC with defective 8088 firmware. (See "Bug in Early 8088 Arises Later, Reader and Author Explain Fix," July 1984 BYTE, page 38.) According to Mr. Janzen, who devised the fix, Mr. Higgins's touch-up will not work.

In the original discussion, Messrs. Roskos and Janzen concluded that pushf/cli/popf would work for most applications and, when using a stack switch, that the code needed to be analyzed before cli/sti could be added to the program.

Mr. Higgins, however, saw another option for the stack switch: why not use lahf/sahf? If another register, perhaps BX, were available, you could save and restore the flags without analyzing the code and inserting cli/sti instructions. Mr. Higgins's suggestion is shown here in listing A.

Mr. Janzen reports that, unfortunately, the lahf and sahf instructions cannot surround critical sections of code, temporarily disable interrupts, and then restore the interrupt flag to its previous value.

"The lahf and sahf instructions . . . do not do this. They appear to have been included in the 8086 instruction set to make it easier to convert existing 8080 programs."

Writes Mr. Janzen: "These instructions transfer the lower 8 bits of the 8086 flags register to and from an AH register. The interrupt flag is one of the upper 8 bits and is not affected by the lahf and sahf instructions. Therefore, the sequence of instructions [suggested by] Mr. Higgins will leave interrupts disabled, rather than restoring the flag."

The pushf/cli sequence suggested by Mr. Roskos is endorsed by Mr. Janzen when it is used for surrounding any critical sections that do not move the stack. If you have a block of code that you know is a part of a routine that runs with interrupts enabled, Mr. Janzen recommends you use cli/sti. If you don't know which way to go, he suggests saving and restoring the entire flags register with the program in listing B.

Listing A: Mr. *Higgins's solution for the disabling/enabling problem in early* 8088 *microprocessors uses the sequence* lahf/sahf.

```
dev_strategy:
          ; switch to local stack
          lahf                        ; save flags in register AH
          cli                         ; disable interrupts
          mov   spsave,sp             ; save DOS's stack pointer
          mov   sssave,ss             ; . . . and stack segment regs
          mov   bx,cs                 ; set up a local stack in
          mov   ss,bx                 ; . . . this code segment
          mov   sp,offset stkbot      ; bottom of local stack
          sahf                        ; restore flags to previous status
          .
          .
          .
          ; switch back to DOS's stack
          lahf                        ; save flags in AH
          cli                         ; disable interrupts
          mov   ss,sssav              ; restore DOS's stack segment
          mov   sp,spsav              ; . . . and stack pointer
          sahf                        ; restore flags to previous status
          ret
```

Listing B: *Save and restore the entire flags register with this program.*

```
criticalsection:
          pushf                       ;push flags register onto stack
          pop ax                      ;save flags in an unused register
          cli                         ;disable interrupts
          .
          .                           ;switch to local stack as before
          .
          push ax                     ;put the old flags on stack
          popf                        ;restore contents of flags register
```

Carroll Touch Technology Relocates

Ann Marett, marketing communications manager for Carroll Touch Technology, wrote to say that her company has relocated since it was mentioned in a System Review in the July 1984 BYTE. (See "The Sage II and Sage IV Computers," by Allen Munro, page 235.)

The correct address for Carroll Touch Technology is POB 1309, Round Rock, TX 78680. The telephone number is (512) 244-3500.

(continued)

BYTE'S BUGS

Patch Now Quilt

A trio of program lines were inadvertently omitted from listing 1, the type-justification patch, in the September 1984 Fixes and Updates (page 33). (See "Patch Justifies Model 100 Type.") Add the lines in listing C to the program.

Our thanks to Frederick Crane of Iowa City, Iowa, for catching this bug.

Listing C: A *patch to the Model 100 type-justification program.*

```
302 FOR Q=VTOR-L+1:IF LEN(PR$)>=R-L+1 THEN 314
314 IF RIGHT$(PR$,1)=" "THENPR$=LEFT$(PR$,LEN(PR$)-1:GOTO302
315 IF LEN(PR$)>R-L+1THENPR$=RIGHT$(PR$,LEN(PR$)-1):GOTO315
```

Bugs in Real-Time Graphics

Marcus Newton found a few bugs in listing 1 in his "Real-Time 3-D Graphics for Microcomputers" (September 1984, page 251).

Make the following changes on page 256: delete the comma after POP DS and change MOV AX,' to MOV AX,' ' (note that there are two spaces between the single quotation marks).

On page 272, change MOV AL,' to MOV AL,' ' (one space between the single quotation marks). Substitute CMPAL,'.' for CMP,AL,".

On page 270, replace the lines around the label PER70 with listing D.

Listing D: *Apply this patch around the label* PER70 *in Marcus Newton's program in the September* 1984 BYTE.

```
        ADD     H,AX        ;H = ZX*X+ZY*Y+ZZ*Z
        MOV     AX,H
        CALL    INORM       ;BX STILL = SQRT Q
        CMP     AX,CCLIP
        JLE     PER90       ;POINT NOT IN FRONT OF CAMERA
PER70:  TEST    P,0FH       ;TRUE PERSPECTIVE
        JZ      PER80
PER75:  MOV     BX,H
PER80:  MOV,    AX,I
        CALL    INORM
        MOV     I,AX        ;I = NORM*I/BX
        MOV     AX,J
        CALL    INORM
        MOV     J,AX        ;J = NORM*J/BX
        CALL    PLOT        ;PLOT PIXEL OR DRAW VECTOR
```

Bang Is Dud

Pat McHargue wrote to tell us that an error mars Dick Pountain's listing in the August 1984 BYTE U.K. (See "Microcomputer Design," page 361.) The process bang, as defined in listing 1 on page 364, is incorrect. At present, it does not print "WHAM!" on the screen; rather it outputs "HM." The correct definition is presented here in listing E.

Listing E: *Corrections to the process bang.*

```
PROC bang (CHAN send) =
  DEF bang.word = "WHAM! ":
  SEQ i = [1 FOR bang.word[BYTE 0]]
    send ! bang.word[BYTE i]:
```

Symbolic Changes

Dr. Michael W. Ecker found a bug in the sample animation program that accompanies Bill Sudbrink's review of the Sanyo MBC 550 microcomputer (August 1984, page 270).

In listing 1 (page 282), change the greater-than symbol (>) in line 150 to a less-than symbol (<), otherwise the down-arrow key will not function as intended.

Book Gets Wrong Name

In the August Fixes and Updates section, we inadvertently misstated the name of one of Scot Kamins's books (on page 40). The correct name is *Apple Backpack.*■

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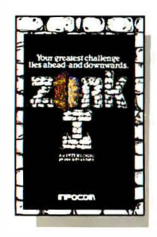
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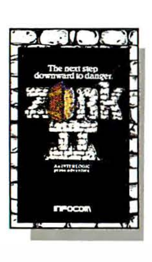
Phone Number ( ) ______________

My computer is ______________

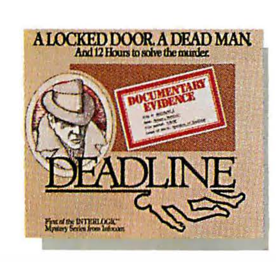
Send to: Hewlett-Packard, 16399 W. Bernardo Drive, San Diego, CA 92127-1899
Attn: Marketing Communications

11404 BT1


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The next step downward to danger.
ZORK II
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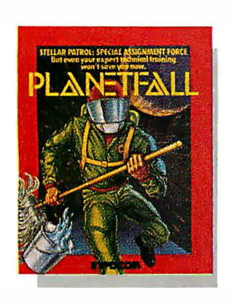

It all comes down to this
ZORK III
INFOCOM

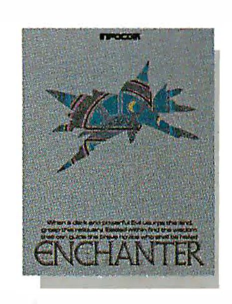

A LOCKED DOOR. A DEAD MAN.
And 12 Hours to solve the murder.
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DEADLINE
First of the INTERLOGIC™ Mystery Series from Infocom

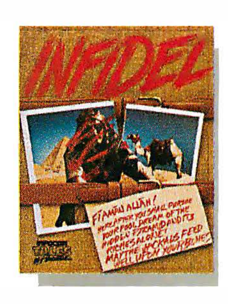

INSIDE!
The WITNESS
SOMEBODY'S GOING TO TAKE THE DEEP SIX!

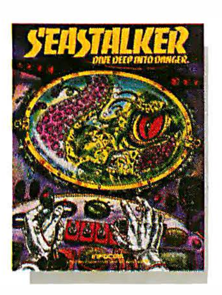

STARCROSS
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AND NOW FOR SOMETHING INCOMPLETELY DIFFERENT!

Incomplete, yes.
But it's not just because we're always bringing out new stories in the Infocom interactive fiction collection. Nor is it simply due to the fact that with all the writing and re-writing, honing and perfecting that we put into every one of our stories, our work is seemingly never done.

The real reason is: an Infocom work of fiction can never be complete until you become a part of it.

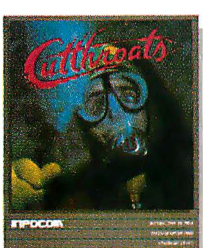
You see, as hard as we work at perfecting our stories, we always leave out one essential element—the main character. And that's where you enter in.

Once you've got Infocom's interactive fiction in your computer, you experience something akin to waking up inside a novel. You find yourself at the center of an exciting plot that continually challenges you with surprising twists, unique characters (many of whom possess extraordinarily developed personalities), and original, logical, often hilarious puzzles. Communication is carried on in the same way as it is in a novel—in prose. And interaction is easy—you type in full English sentences.

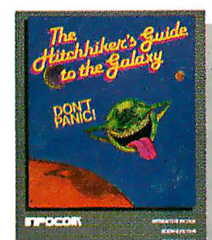
But there is this key difference between our tales and conventional novels: Infocom's interactive fiction is active, not passive. The course of events is shaped by the actions you choose to take. And you enjoy enormous freedom in your choice of actions—you have hundreds, even thousands of alternatives at every step. In fact, an Infocom interactive story is roughly the length of a short novel in content, but because you're actively engaged in the plot, your adventure can last for weeks and months.

In other words, only you can complete the works of Infocom, Inc. Because they're stories that grow out of your imagination.

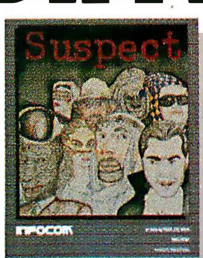
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In CUTTHROATS,™ the plot involves a motley band of hardbitten salts who get wind of a shipwreck laden with sunken treasure near the remote island where you live. In exchange for your diving skills, they offer you a piece of the action. Your challenge: survive them, the perils of the deep, and escape with the treasure and your life. Good luck!



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In SUSPECT,™ our newest mystery thriller, you're a reporter who gets the scoop on the society event of the year—the murder of a Maryland Blue Blood at a fancy costume ball. Great! Except you're the prime suspect. And if you can't find the real killer, your next by-line could be in the obituaries.

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Texas Instruments Adds Briefcase Portable



The briefcase-size Pro-Lite portable computer is compatible with Texas Instruments' Professional Computer. Pro-Lite includes one 720K-byte 3½-inch floppy-disk drive, an 80C88 microprocessor, an 80-column by 25-line liquid-crystal display, and 256K bytes of memory, expandable to 768K.

Two internal expansion slots can be used for a 300-bps modem, an external color monitor interface, an RS-232C interface, or a "solid-state software" ROM card. A second 3½-inch disk drive and an eight-hour battery pack are available as external expansion options and attach to the rear of the Pro-Lite. An optional interface cable allows the Pro-Lite to be linked to any MS-DOS computer to transfer files; the Pro-Lite can emulate an external disk drive to simplify file transfers.

Without the battery pack, the Pro-Lite weighs 10.5 pounds with one disk drive or 13.5 pounds with both drives. The Pro-Lite will be available this month through national account direct sales and value-added resellers for $2995; TI will make it available through retail channels at a later date. Contact Texas Instruments Inc., Data Systems Group, POB 809063, Dallas, TX 75380-9063, (800) 527-3500.
Inquiry **540.**

Rolm Unveils Computer/Telephone Systems

Rolm has introduced two new systems combining personal computers with Rolm telephone systems. Cedar is a complete IBM PC-compatible computer and multiline digital telephone, and Juniper is a telephone attachment for the IBM PC. Both systems can only be used by companies that have Rolm's CBX private branch exchange (PBX). Both can emulate DEC or IBM terminals to access mainframes.





Cedar includes a multiline digital telephone, a speakerphone, an IBM-compatible personal computer, and communications hardware and software allowing communications over internal phone lines at up to 19,200 bps. Cedar and Juniper can also access modems attached to the CBX system to communicate with the outside world. The system includes 512K bytes of memory, two 5¼-inch disk drives, a 9-inch monitor, and MS-DOS 2.11.

Juniper consists of an adapter board for the IBM PC, software, and a multiline digital telephone with a two-way speakerphone. It requires an IBM PC with 256K bytes of memory.

Cedar is priced at $4995, and Juniper is $1495. In quantities of 100, the prices are $4245 and $1360, respectively. Contact Rolm Corp., 4900 Old Ironsides Dr., Santa Clara, CA 95054, (408) 986-1000.
Inquiry **541.**

(continued)

Okidata Introduces $268 Color Printer

Okimate 20 from Okidata combines thermal-transfer and dot-matrix technologies in a $268 full-color printer. Its 24-pin square-dot print head can produce a resolution of up to 144 by 144 dots per inch. Okidata says the Okimate 20 can print more than 100 different shades by mixing the four ribbon colors. The thermal-transfer technology doesn't require special thermal paper—it can print on plain paper, letterhead, or overhead transparencies.

The Okimate 20 also includes either a parallel or serial "Plug 'N Print" interface, which means the printer can be used with most personal computers. It can print 80 characters per second (cps) in draft mode, or 40 cps in letter-quality mode.

For more information, contact Okidata, 532 Fellowship Rd., Mt. Laurel, NJ 08054, (609) 235-2600.

Inquiry **542.**



Video for the Mac

Mentaur Technologies has introduced a solid-state, compressed-circuitry, video-output device for the Macintosh. The Mentaur Composite Video Adaptor provides a composite video signal of the Macintosh screen through a built-in, standard BNC connector. This lets the operator use the Macintosh with large-screen video projectors and monitors for business or educational applications.

The Mentaur CVA installs with no soldering, wire splicing, or mounting hardware. Illustrated instructions are included. This device eliminates the need for hard-wire modifications and interface units.

Documentation includes projector and monitor manufacturer information. The Mentaur CVA lists for $199.95. Contact Mentaur Technologies, POB 1467, San Marcos, TX 78666, (512) 396-1565.

Inquiry **543.**

PC-Compatible Seequa Cobra Features 16-bit Expansion Bus

The Seequa Cobra is an IBM PC-compatible computer with an extended PC AT-compatible 16-bit expansion bus. The Cobra uses an 8086 processor with a clock speed of 8 MHz, switchable to the standard IBM PC rate of 4.77 MHz. Seequa says another function of the 16-bit hardware bus is to produce a flicker-free image for the Cobra's color-graphics display.



In addition to the 8086, the Cobra features a Z80 processor, 256K bytes of memory, one 5¼-inch floppy disk, a 10-megabyte hard disk, a clock/calendar, and parallel and serial ports. Seequa bundles WordStar, SuperCalc, and a number of other programs with the Cobra.

Seequa plans to release the Cobra in March for $4995 without a monitor. Contact Seequa Computer Corp., 8305 Telegraph Rd., Odenton, MD 21113, (301) 672-3600.

Inquiry **544.**

Juki Announces $299 Daisy-Wheel Printer

The Juki 6000 is a portable letter-quality printer that uses standard daisy-wheel print elements and ribbons. The printer weighs about 13 pounds and measures 16 by 9¼ by 5½ inches. It prints at a speed of 10 characters per second on paper up to 9 inches wide.

The Juki 6000 is available with either serial or parallel interfaces and can print at 10, 12, or 15 characters per inch using any Diablo-type daisy wheel.

List price of the Juki 6000 is $299. Contact Juki Industries of America, 299 Market St., Saddle Brook, NJ 07662, (201) 368-3666.

Inquiry **545.**

(continued)

Available for the IBM PC, AT, XT, jr., and true compatibles*

GOT YOUR SIDEKICK™ YET?

The Super Organizer

Whenever you're using your computer . . . from start to finish of your session Sidekick™ will be there . . . ready to serve. And it's as lightning-fast and compact as only Borland knows how to make it.

There's a notepad that has a full-screen editor that can time and date stamp your notes, and then save them to disk. You can even pull information into the notepad directly from the screen of your "underlying" software.

Suppose you're working in Lotus and the phone suddenly rings. Give your Sidekick a call and it pops right up over Lotus with the notepad you need. Or an appointment calendar . . . one you can never misplace.

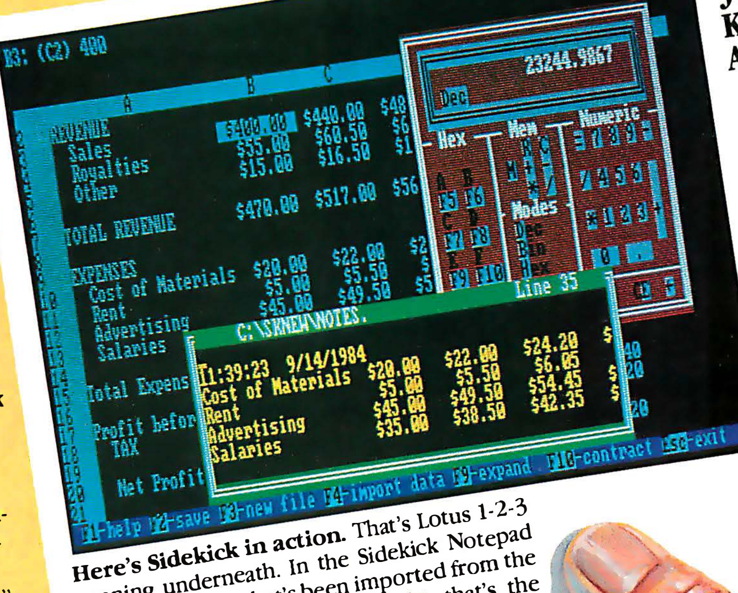
What if you need to do a quick calculation? A keystroke instantly brings up the calculator. And the results of your calculations can even be transferred to your "underlying" software.

Need to make a phone call? Up pops your personal phone directory. Type in the name you want . . . and Sidekick jumps right to the phone number. Another keystroke, and the phone is automatically dialed for you.**

There's lots more, too. You can move the Sidekick windows anywhere on the screen you like. And you can have as many on screen at a time as you need. There's even an on-line help window for each of Sidekick's features.

We designed it because we needed it. If you've ever been writing a report and needed to do a quick calculation, or jot down a note, then you need Sidekick, too.

***Only with Hayes Smartmodem and compatibles.*



Here's Sidekick in action. That's Lotus 1-2-3 running underneath. In the Sidekick Notepad you can see data that's been imported from the Lotus screen. On the upper right, that's the Sidekick Calculator.

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Device for Macintosh Uses Removable 5-Megabyte Cartridges

Iomega has introduced a 5-megabyte version of its Bernoulli Box for the Apple Macintosh. The Bernoulli Box uses removable cartridges that contain floppy-disk-like media with an average access time of 50 milliseconds.

Iomega also makes 10- and 20-megabyte versions of the Bernoulli Box for the IBM PC and compatibles; the Mac Bernoulli Box is not compatible with the IBM version. Mac Bernoulli Box cartridges can be exchanged with any other Macintosh, however, allowing transfer of large quantities of data on a single disk. The 5-megabyte cartridges are physically smaller than the 10- and 20-megabyte cartridges.



The Mac Bernoulli Box costs $1895; cartridges are $65 each. For further information, contact Iomega Corp., 4646 South 1500 W, Ogden, UT 84404, (801) 399-2171.

Inquiry **546.**

HyperDrive Internal Hard Disk for the Macintosh

General Computer Company has introduced HyperDrive, a hardware expansion for Apple's Macintosh computer combining a 512K-byte memory upgrade and an internal 10-megabyte hard-disk drive. The company connects the HyperDrive's logic board directly to the Macintosh's main circuit board and fits the disk drive inside the computer. Users can boot from either the floppy or the hard disk. Both Macintosh serial ports remain free for modems, printers, or network use. Software is included to partition the hard disk into many virtual disks, which are automatically resized to accommodate the user's files.

Hyperdrive will be available this month for $2795; for Macintoshes already equipped with 512K bytes of RAM, the price is $2195. For more information, contact General Computer Corp., 215 First St., Cambridge, MA 02142, (800) 422-0101; in Massachusetts, (617) 492-5500.

Inquiry **548.**

Thesys Offers 5-Megabyte RAM Expansion System for $3495

Fastfile stores up to 5 megabytes of data in a stand-alone device with an access time of less than 250 nanoseconds. Fastfile uses 256K-byte RAMs and features an uninterruptible power supply to prevent loss of data. Also included are an expansion card for the IBM PC and software for print spooling and disk caching. While Fastfile will speed up ordinary PC applications, the company stresses that it can also be used to improve the performance of a local-area network.

Fastfile will be available for the IBM PC in January, according to the manufacturer. It measures 5.3 by 9.7 by 12.4 inches. Fastfile will cost $1795 with 1.5 megabytes, $2795 with 3 megabytes, and $3495 with 5 megabytes. Contact Thesys Memory Products Corp., 7345 East Acoma Dr., Scottsdale, AZ 85260, (602) 991-7356.

Inquiry **547.**

Whitechapel Workstation Displays 1024 by 800 Pixels

Whitechapel Computer Works' graphics workstation has a resolution of 1024 by 800 using the National Semiconductor 32016 processor. The MG-1 includes 512K bytes of memory, a 10-, 22-, or 45-megabyte hard disk, an 800K-byte 5¼-inch floppy-disk drive, a high-resolution display, a mouse, and the Genix operating system. Main memory can be expanded to 4 megabytes.

Its UNIX-based operating system and optional Ethernet link are designed to enhance the system's usefulness in computer-aided design and engineering and scientific applications.

The MG-1 is about $6975 with a 10- megabyte hard disk, $8250 with a 22-megabyte hard disk, and $9500 with a 45- megabyte hard disk. Contact Whitechapel Computer Works Ltd., 75 Whitechapel Rd., London E1 1DU, England, tel: 01-377-8680; from the U.S., 011-44-1-377-8680.

Inquiry **549.**

Gifford MC-186 Expands to Multiuser MS-DOS System

Gifford Computer Systems' MC-186 uses both 80186 and Z80H processors to support up to eight users. The MC-186 uses Multiuser Concurrent DOS, based on Digital Research's Concurrent DOS, which enables each user to run four applications concurrently. The MC-186 can be attached to an ARC-NET-compatible DR Net network to link with up to 255 other MC-DOS computers.

The MC-186 includes one megabyte of RAM, a 23-, 44-, or 62-megabyte hard disk, a 1.2-megabyte floppy-disk drive, 10 serial ports, and a single parallel port. Other features are a clock/calendar, a diagnostic EPROM, and an optional network controller board. With a 44-megabyte hard disk, the system costs $13,700.

Contact Gifford Computer Systems, 2446 Verna Court, San Leandro, CA 94577, (415) 895-0798.

Inquiry **550.**

(continued)

NEW PRODUCT NEWS FROM TELETEK

Systemaster II. Responding to market demand for speed and increased versatility, Teletek is proud to announce the availability of the next generation in 8-bit technology — the new Systemaster II! The Systemaster II will offer two CPU options, either a Z80B running at 6 MHz or a Z80H running at 8 MHz, 128K of parity checked RAM, two RS232 serial ports with on-board drivers (no paddle boards required), two parallel ports, or optional SCSI or IEEE-488 port. The WD floppy disk controller will *simultaneously* handle 8″ and 5¼″ drives. A Zilog Z-80 DMA controller will provide instant communications over the bus between master and slave. Add to the DMA capability a true dedicated interrupt controller for both on-board and bus functions, and the result is unprecedented performance. Systemaster II will run under CP/M 3.0 or TurboDOS 1.3, and fully utilize the bank switching features of these operating systems.

SBC 86/87. As the name indicates, Teletek's new 16-bit slave board has an Intel 8086 CPU with an 8087 math co-processor option. This new board will provide either 128K or 512K of parity checked RAM. Two serial ports are provided with individually programmable baud rates. One Centronics-compatible parallel port is provided. When teamed up with Systemaster II under TurboDOS 1.3, this 5MHz or 8MHz multi-user, multi-processing, combination cannot be beat in speed or feature flexibility!

Teletek Z-150 MB. Teletek is the first to offer a RAM expansion board designed specifically for the Z-150/Z-160 from Zenith. The Teletek Z-150 MB is expandable from 64K to 384K. Bring your Z-150 up to its full potential by adding 320K of parity checked RAM (or your IBM PC, Columbia, Compaq, Corona, Eagle, or Seequa to their full potential). The Teletek Z-150 MB optionally provides a game port for use when your portable goes home or a clock/calendar with battery backup!

Evaluate the Systemaster II, SBC 86/87 or Teletek Z-150 MB for 30 days under Teletek's Evaluation Program. A money-back guarantee is provided if not completely satisfied! All Teletek products carry a 3-year warranty.

(Specifications subject to change without notice.)

TELETEK

4600 Pell Drive
Sacramento, CA 95838
(916) 920-4600
Telex #4991834
Answer back — Teletek

Inquiry 349

Yes, I'm interested in information regarding:

- ☐ Systemaster II
- ☐ SBC 86/87 ☐ Z-150 MB
- ☐ Evaluation Program
- ☐ Teletek's S-100 Board Line

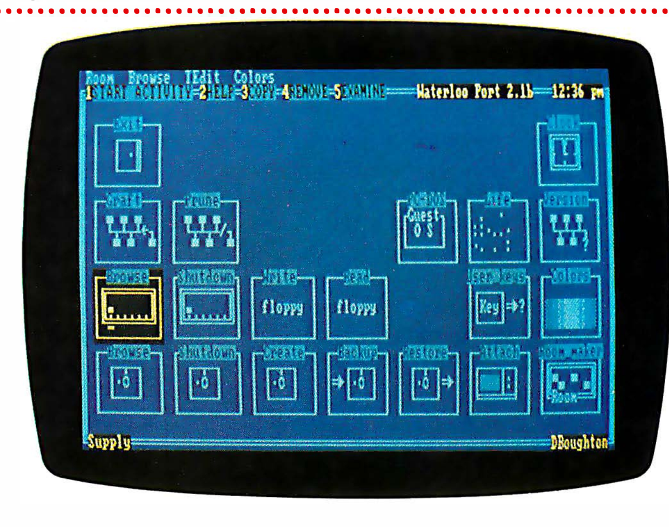
Name ____________

Company ____________

Address ____________

____________ 1B

Networking Operating System for IBM PC



Waterloo Port is a networking operating system for IBM personal computers and compatibles. According to the manufacturer, Port users can run such applications as Lotus 1-2-3, WordStar, MultiMate, dBASE II, and Advanced BASIC using PC-DOS 2.1 as a "guest operating system" under Port. Port also includes a built-in Text Editor and Text Formatter. Port allows several tasks to execute concurrently; they can be displayed as separate on-screen windows or can be hidden from view until selected.

Port uses icons and "offices" for each application function; selections can be made using the keyboard or an optional mouse. With Port, network users can share printers and other peripherals. Diskless workstations can download software, including the operating system, through the network.

Waterloo Port also allows users to access mainframe computers through the network. Port includes its own development system and programming language to develop network-based software. Processes can pass messages to each other through the network, enabling real-time multiuser applications to be developed.

Software and hardware to convert an IBM PC into a Waterloo Port software server is $1540. Workstations can be added to the network with a $920 software/hardware package. For more information, contact Waterloo Microsystems Inc., 175 Columbia St. W., Waterloo, Ontario N2L 5Z5, Canada, (519) 884-3141.

Inquiry **551.**

MicroPro Enhances WordStar

MicroPro's WordStar 2000 adds a number of features to its popular WordStar word-processing program. Some of the enhancements are an Undo command to restore deleted text, use of windows to view up to three documents simultaneously, user-definable function keys, a "keystroke glossary" for frequently typed text or command sequences, footnoting, spelling correction, proportional spacing, and on-screen boldfacing, underlining, centering, and pagination.

WordStar 2000 also includes some spreadsheet and database features. It can perform calculations within a document, sort lists of text or numbers, and merge data into letters for customized mailings.

A separate version, called WordStar 2000 Plus, adds telecommunications, a mailing list database program, and indexing and table of contents capabilities.

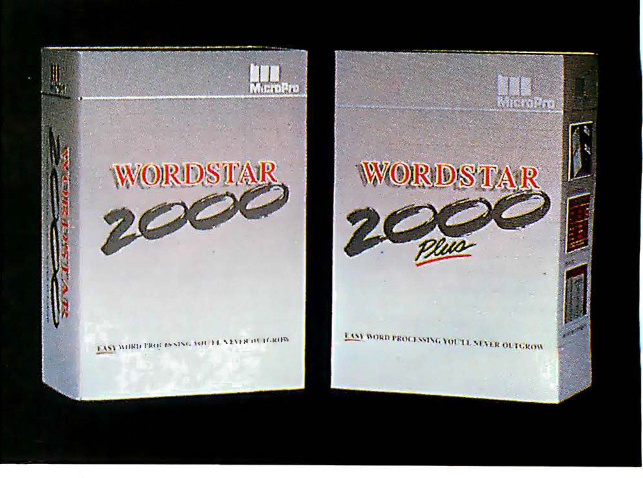
WordStar 2000 requires an IBM PC or compatible with PC-DOS 2.0 or later, 256K bytes of memory, and two double-sided disk drives; a hard disk is recommended. WordStar 2000 Plus requires a Hayes Smartmodem or compatible modem to use the telecommunications features.

WordStar 2000 is $495; WordStar 2000 Plus is $595. Current WordStar owners can upgrade to WordStar 2000 for $250 or WordStar 2000 Plus for $350. For more information, contact MicroPro International Corp., 33 San Pablo Ave., San Rafael, CA 94903, (415) 499-1200.

Inquiry **552.**

(continued on page 440)





Brighten up your dumb terminal—add a UDS 212 A/D

A little outside intelligence can turn your dumb terminal into a data communications genius. And the intelligence you need is built into UDS' new 212 A/D, a smart 300/1200 bps modem with an integral automatic calling unit.

With the 212 A/D you can dial from keyboard or, with a single keystroke, from memory. Five 30-digit numbers in memory are battery backed for 3-5 year retention after shutdown. Built-in test functions allow fast, reliable verification of system operation.



Before you invest in more microcomputers, check the advantages of add-on intelligence. **Call 800/633-2252, ext. 353.** Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone 205/837-8100; TWX 810-726-2100.

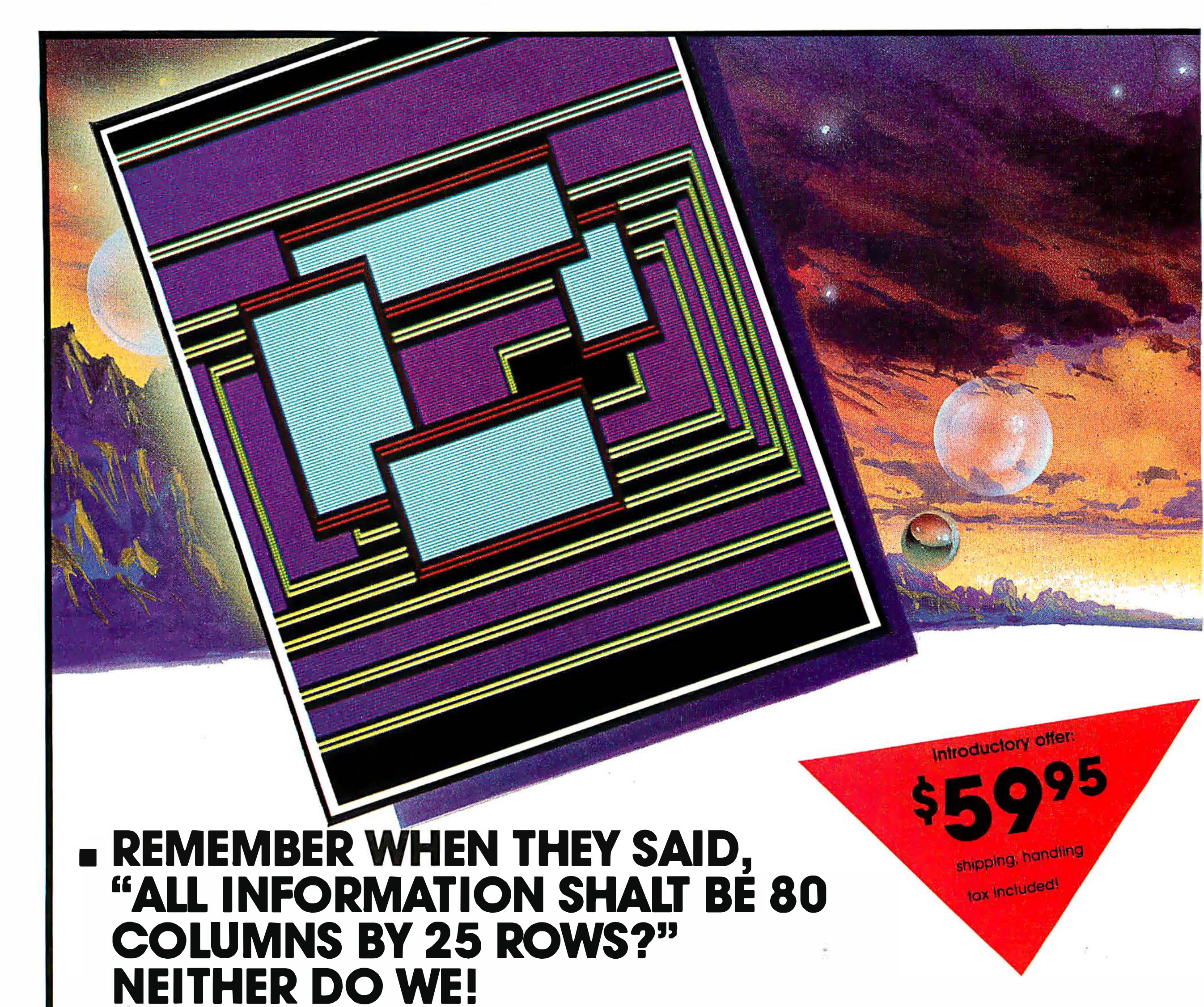
Universal Data Systems



Inquiry 357

UDS modems are offered nationally by leading distributors. Call the nearest UDS office for distributor listings in your area.
DISTRICT OFFICES: **Atlanta**, GA, 404/998-2715 • **Aurora**, CO, 303/368-9000 • **Bellevue**, WA, 206/455-4429 • **Blue Bell**, PA, 215/643-2336 • **Boston**, MA, 617/875-8868 **Columbus**, OH, 614/895-3025 • **East Brunswick**, NJ, 201/238-1515 • **Glenview**, IL, 312/998-8180 • **Houston**, TX, 713/988-5506 • **Huntsville**, AL, 205/837-8100 **Mesa**, AZ, 602/820-6611 • **Minnetonka**, MN, 612/938-9230 • **Mountain View**, CA, 415/969-3323 • **Richardson**, TX, 214/680-0002 • **Silver Spring**, MD, 301/942-8558 **Tampa**, FL, 813/684-0615 • **Thousand Oaks**, CA, 805/496-3777 • **Tustin**, CA, 714/669-8001 • **Willowdale**, Ont, Can, 416/495-0008 • **Ypsilanti**, MI, 313/483-2682

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REMEMBER WHEN THEY SAID, "ALL INFORMATION SHALT BE 80 COLUMNS BY 25 ROWS?" NEITHER DO WE!

ALL INFORMATION ISN'T CREATED EQUAL . . . AT LEAST NOT IN SHAPE OR SIZE.

Whoever said information is always 80 columns by 25 rows? Check the directory on your PC sometime. Long and skinny. Got any ideas on what to do with the other half of the screen?

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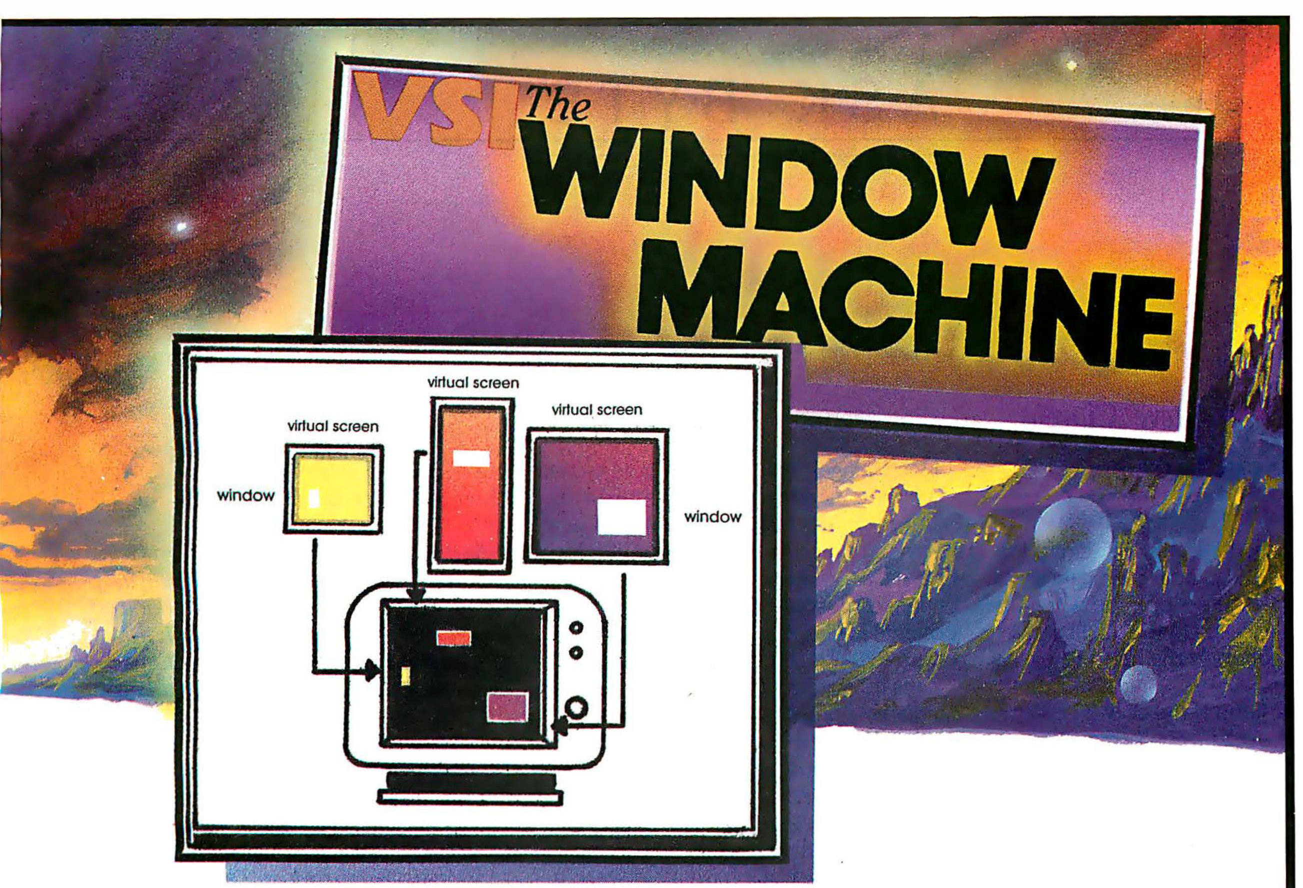
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Conducted by Steve Ciarcia

80-Column in Slot 3

Dear Steve,

Your August 1984 Ask BYTE column stated that an 80-column card cannot be used in slot 3 of the Apple IIe when another card is installed in the auxiliary slot. While this is generally the rule, there is an exception.

Videx's UltraTerm is the only 80-column card that will work in slot 3—even if there is another card in the auxiliary slot. With compatible software, such as Word Juggler IIe and Multiplan 1.07, the UltraTerm's 128-column by 32-line display can be used in conjunction with the extra memory of the Apple extended 80-column card. For programs that exclusively use the Apple 80-column card (PFS series for the IIe), an optional switch plate is available to toggle between the UltraTerm and the Apple text card's display.

For a list of spreadsheets, word processors, and databases that utilize the expanded display features of the UltraTerm on the Apple IIe, BYTE readers should call Videx at (503) 758-0521.

William Leineweber
Videx
Corvallis, OR

High-Resolution Confusion

Dear Steve,

As a new subscriber to BYTE, I was delighted to find your Ask BYTE column as a help for the perplexed (me).

I'm hoping you can offer some desperately needed information on a most confusing subject, namely, how are high-resolution graphics created? Are they the product of hardware, software, or both?

In looking through BYTE ads, I've seen monitors, processors, software, and printers all described as possessing high resolution. For example, Quadram's QuadScreen monitor features "bit-mapped graphics (that) allow dot-addressable resolution of 960 horizontal by 512 vertical (pixels)." Wang recently introduced a desktop scanner for its Professional Computer that digitizes images at a resolution of 200 dots per inch (1728 by 2200 pixels for the maximum 11- by 14-inch image). Yet the Wang Professional Computer monitor has an advertised resolution of only 800 by 300 pixels. Many microcomputers have add-on graphics boards and image processors offering enhanced resolution; e.g., the PC Components Bi-Graphix board for the IBM PC offers 720- by 700-pixel resolution with "software support for higher resolution." Similarly, printers are rated at dots per inch with varied high-density settings for high-resolution graphics.

Just how does one go about creating high-resolution (say, 150 to 200 dots per inch horizontally and vertically) graphics hard copy? Must one have a high-resolution graphics-board-equipped computer with graphics-support software outputting through a high-resolution monitor to a high-resolution printer? Help!

Betsy McCloskey
Los Angeles, CA

Producing a high-resolution graphics display with a microcomputer depends primarily on features built into the hardware, but software is required to drive the hardware to achieve the desired display characteristics. This is usually in ROM when it is included as a standard feature of a personal computer.

First, a microcomputer that can produce graphics has a video-display controller with graphics capability and enough screen memory to produce a bit-mapped image with the desired resolution built into it. The controllers used these days are usually one-chip integrated circuits that can produce either graphics or text displays. Motorola application note AN-834 (Motorola Semiconductor Products Inc., POB 20912, Phoenix, AZ 85036) shows how the MC6845 can be used to produce a 256- by 256-pixel or 512- by 512-pixel graphics display. This chip is also used in the IBM PC to produce 320 by 200 color graphics or 640 by 200 monochrome graphics. The actual bit map produced depends on the memory allocated and the software (or firmware) driving the display.

You can also see how another chip, the Texas Instruments TMS9918A, can be used to produce graphics with sprites in my article "High-Resolution Sprite-Oriented Color Graphics" in the August 1982 issue on page 57.

To display the high-resolution graphics requires a high-resolution monitor. The QuadScreen monitor you mentioned is a high-resolution monitor with its own graphics video-driver card, which is made to replace the display driver card in the IBM PC. This system can produce a 960- by 512-pixel display, but the usual IBM PC commercial software requires special interface routines to use this resolution, and the PC's BASICA is still limited to 640 by 200 by its own structure. More conventional 12- or 13-inch color (RGB) or monochrome monitors with 15- to 20-MHz video bandwidths are available that can make full use of the standard- or second-source video cards for the IBM PC and compatible computers, as well as many other computers with graphics built in.

Creating high-resolution graphics on paper with a printer or plotter is a different story. This doesn't even require graphics capability in the computer. All you have to do is set up an array of points to be plotted and send the points to a printer with dot-graphics capability. The programming is a little complicated because you must first define the dot array you want printed and then sort it into a form the printer can use. This usually means that you must arrange the data to be plotted in a top-down, line-by-line array. Since the print head has seven or eight print wires in a vertical column that can be used in graphics mode, the graphics lines are taken seven or eight at a time and read as columns of dots. These are coded into 1-byte characters and sent to the printer one at a time. For example, if a given position on the line needs only the top dot printed, the character sent (in BASIC) would be CHR$(1). Similarly, if all eight dots are to be printed, the character would be CHR$(255). The coding system establishes a correspondence between the wire positions and bit positions in the data byte, so that wire 1 has the same value as bit 1, wire 2 with bit 2, etc. This allows easy calculation of the character

(continued)

value to produce a given pattern: simply add the values of the wires to be printed. Since the wires are in the binary sequence 1, 2, 4, 8, 16, 32, 64, and 128, the arithmetic is easy.

Printers with 150 to 200 dots per inch in both directions are available, but most of the low-cost graphics printers are in the 72- to 120-dot-per-inch range.—Steve

No Need to Modify SA-400s

Dear Steve,

In regard to your response to Claudio Pugliese's letter in the June 1984 issue (page 70) concerning Shugart SA-400s for Apples, I think there is a better solution than the one you proposed, which was to modify the SA-400s. I use the Suntronics (12621 Crenshaw Blvd., Hawthorne, CA 90250) AFDC-1 floppy-disk controller to connect two SA-400 drives to slot 6 of my Apple II+. Interfacing is as simple as plugging in the drives; at $55.95 you can't beat it. Furthermore, the drives sound like they did on the Radio Shack instead of the way the Apple drives sound when they seek track zero. The only disadvantage is that the AFDC-1 doesn't support half-tracking. I've never had a problem reading, writing, or copying regular Apple II+-created disks.

Jim Means
Lompoc, CA

SA-400–Apple Interface

Dear Steve,

Regarding an Apple II interface to a Shugart SA-400 disk drive, I have been selling the plans for one such interface for the past two years. It's a highly simplified circuit, consisting of five common TTL chips. The SA-400 PCB requires only two cuts, a resistor substitution, and a chip replacement.

For interested readers, I will supply the schematic for this interface, a parts list, complete instructions, and diagrams for $16 U.S. or $20 Canadian. Please send it to J. Cygman, 158 Leslie St., DDO, Montreal, Quebec H9A 1X3, Canada. Money orders only, please. Or call (514) 683-9392 for information.

J. Cygman
Montreal, Quebec, Canada

PCjr Screen Modes

Dear Steve,

I have an expanded IBM PCjr, and I have not been able to use screen modes 5 and 6. The BASIC manual states that you can use these modes (and others) only if you have 128K bytes and Cartridge BASIC. I have these, and I still get an illegal function call when I attempt to use these modes. I have also experienced the same problem on another PCjr with the same specifications. Can you offer an explanation or a remedy for the problem?

Chris Newbold
Lexington, MA

Before screen mode 5 or 6 can be used on the PCjr, it is necessary to allocate some memory for it. The CLEAR *command does this, among other things. The simplest way to use it is as follows:*

```
10 CLEAR , , ,32768
20 SCREEN 5
```

or

```
10 CLEAR , , ,32768
20 SCREEN 6
```

—Steve

Sons of 8086

Dear Steve,

I have been reading a lot of articles and ads in BYTE featuring computers based on the Intel 80186 microprocessor. Now Intel has introduced a new processor, the 80286. An ad in BYTE says "the 80286 is capable of supporting up to 16 megabytes of physical memory and up to 1 gigabyte of virtual memory when utilized in virtual address mode." What are the differences between the 8086, 80186, and the 80286, and how are the 80286's large memory capabilities accomplished?

Timothy Russell
Bellevue, NE

The 8086 is the first processor in the Intel 16-bit line. The 80186 and 80286 are enhancements on the 8086 and will run most or maybe all 8086 software.

The 80186 is a more integrated system than the 8086 in that it includes, on the chip, most of the "glue" parts that are added externally in 8086 applications, such as timers, interrupt controller, and DMA controller. It also includes a few new instructions like PUSHA and POPA, which push and pop all registers at once, and INS and OUTS for strings. Instruction execution times are the same as the 8086, and clock speeds up to 8 MHz are available. Addressing capability is the same as the 8086.

The 80286 represents evolution of the 8086 family in a different direction. This processor is designed for multiuser sys-

(continued)



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Inquiry 220

tems and has direct addressing for up to 16 megabytes of memory. This is accomplished with a 24-line address bus. This chip also has an enhanced instruction set and protection features to prevent actions by one user from interfering with another or to prevent unauthorized access to specific files (memory areas). Up to 16,383 memory areas can be defined with lengths between 1K and 64K bytes. Calls and jumps within and across protection boundaries and between tasks in multitask applications are included in the instruction set.

The virtual-memory addressing range is up to 1 gigabyte for each user. This is accomplished by providing most of the required capacity on hard disks and transferring blocks in and out of physical memory under control of the processor's memory-management program. This is transparent to the user, so that it appears to be the same as "real" memory, although each user gets only as much physical memory as is needed.

Virtual memory can be done in a limited fashion with the 8086 and other processors, but the 80286's architecture and instruction-set enhancements are optimized for this application.—Steve

HARDWARE-OS INTERFACING

Dear Steve,

I am an engineer who specializes in digital hardware. I intend to build a home computer. My problem is that I do not know how to interface my hardware to an operating system. Can you help?

RICHARD GOODRICH
Richardson, TX

Interfacing between the operating system and the hardware was discussed briefly in my article "Build the Circuit Cellar MPX-16 Computer System, Part 3" in the January 1983 BYTE (page 54). As mentioned in that article, the CP/M-86 manuals from Digital Research give the details of writing the BIOS, which is basically a set of device drivers that provides the interface between the operating system and your specific hardware.

The IBM PC Technical Reference Manual *gives a good example of a BIOS for 8088/8086-based systems in Appendix A. This contains many of the interrupt-service routines used by the PC for I/O to the keyboard, printer, serial ports, disk drives, and screen as well as the bootstrap loader.*

A few books on operating systems are

(continued)

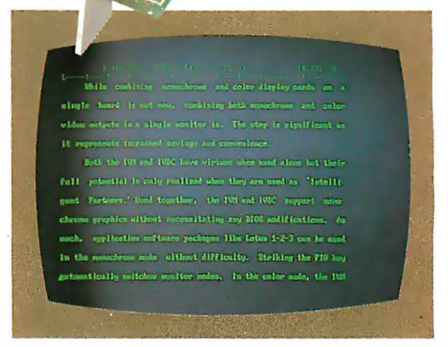
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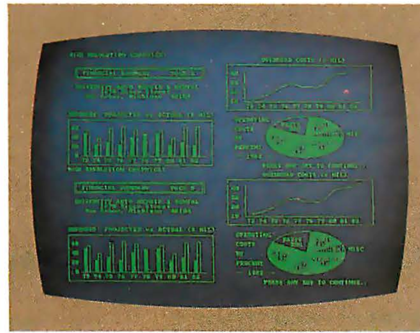
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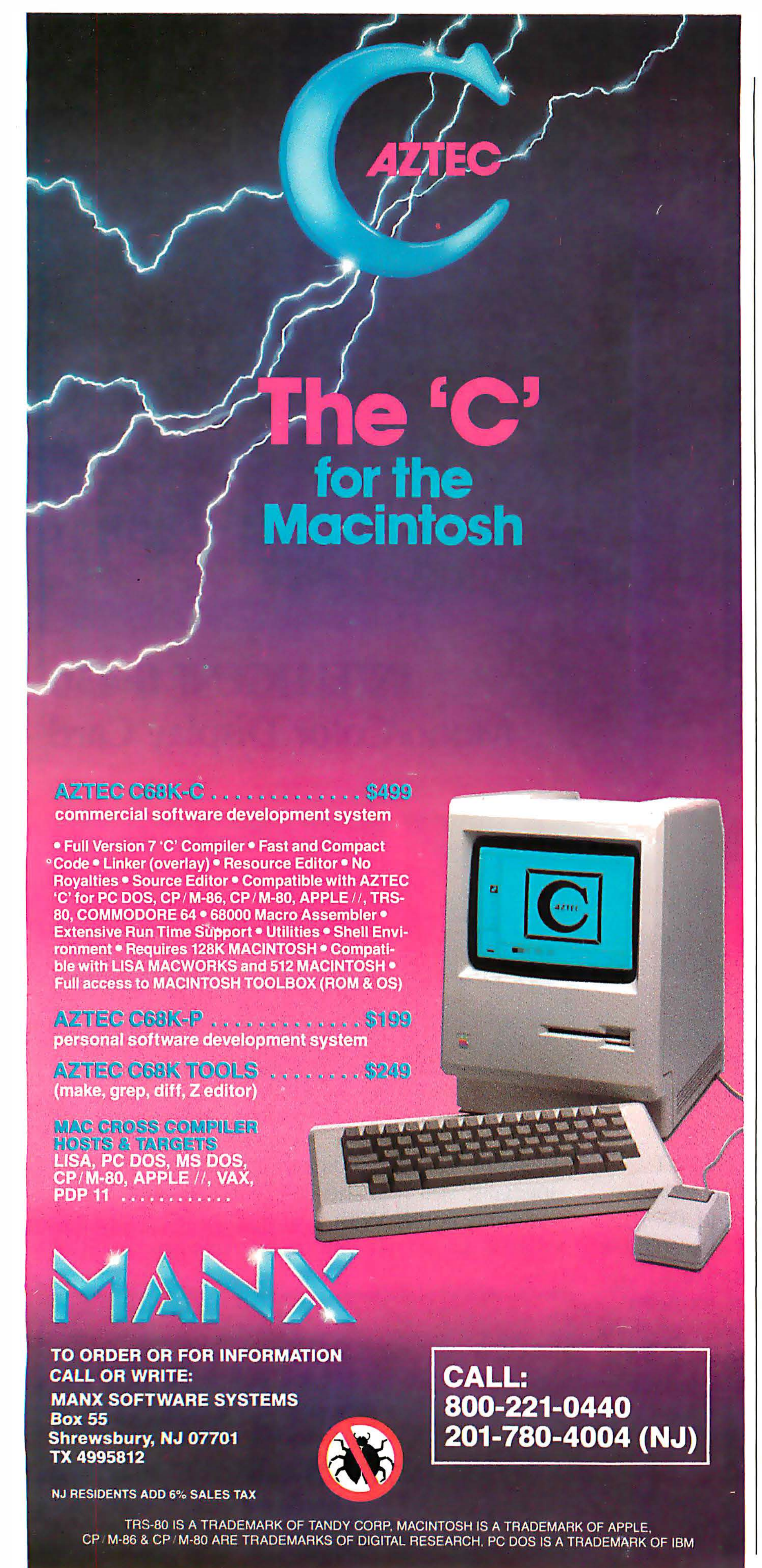
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available. Three you might check out are Microcomputer Operating Systems *by Mark Dahmke,* Operating Systems *by Harold Lorin and Harvey Deitel (both from McGraw-Hill), and* The Design of Operating Systems for Small Computer Systems *by Stephen H. Kaisler (John Wiley & Sons).*—Steve

TAPE-DRIVE CONTROLLERS

Dear Steve,

I plan to buy an IBM PC or an MPX-16. I want to have two floppy-disk drives and two IBM 9-track tape drives. I want to be able to format the tapes, not just use them as streaming backup. I do not care whether a mainframe can read my tapes or vice versa.

Where can I get a controller for these drives, or can it be done by software? I know a manufacturer who makes a nice system, but I am thinking of used drives for $500 each.

ROGER CAIN
Ottawa, Ontario, Canada

You definitely need a controller to hook 9-track drives onto a PC. Luckily, several manufacturers make such controllers and the software to go with them. I have not used these products, so I can't tell you how well they perform. These controllers are in the $500 to $1000 price range. Contact the manufacturers directly to get current information.

Ibex Computer Corp.
20741 Marilla St.
Chatsworth, CA 91311
(818) 709-8100

Innovative Data Technology
4060 Morena Blvd.
San Diego, CA 92117
(619) 270-3990

Good luck with your project.—Steve ■

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You are not a machine.

Computers are designed by engineers.

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Which is why so many computers often are technically impressive yet strangely unnatural to use.

Computer-induced problems (%)	
Eye strain	55%
Back pain	43%
Headaches	30%
Shoulder	25%
Hand/wrist	18%
Neck pain	15%

(Source: "Ergonomic Principles in Office Automation" Pub. 1983 by E.I.S. AB, Sweden.)

The result has been a whole range of computer-induced problems ranging from stress and fatigue to blurred vision.

In Sweden, they have an attitude the world is just catching up with.

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Thousands of people get neck and back pain from inadequate screen height and angle adjustment.

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Ericsson keys are full-size, and the layout is ergonomically planned for greater speed and accuracy.

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Even the cord is adjustable to suit left- or right-handers.

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It even fits under your desk in a special vertical rack.

So your desktop is your own again.

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Many companies claim to be compatible.

Some are. Some are stretching the truth.

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The bulletin board of the CompuPro Users Group is up and running at (703) 491-1852, operable via modem at 300 or 1200 bps. A remote CP/M system is also available. Members of the group produce a newsletter regularly that contains software reviews, hardware help, and tips. Annual membership is $20. Call Don Kelley at (703) 690-3312, or write Toni Bennett, C-PRO Users Group, 14057 Jefferson Davis Highway, POB 1474, Woodbridge, VA 22193.

● ADAM ON THE HUDSON
Members of the Metropolitan Adam Users Group from the New York–New Jersey area meet in New York City at 7 p.m. on the second and fourth Thursdays of every month. Information and experiences with the hardware, software, and related literature are shared. At present, no dues have been set; a newsletter is in the early stages of production. Contact Russell Williams, 414 West 149th St., New York, NY 10031, (212) 208-0645.

● BUGS ON THE WEST COAST—The Basis Users Group Sacramento (BUGS) meets at 7 p.m. on the first Sunday of every month at the Shoreline Software Center in Sacramento, California. A magnetic newsletter allows members to exchange technical notes for a $5 fee. A membership is $20. Contact Ms. Leslie Carroll, BUGS, 125 Faro Ave., Davis, CA 95616.

● THE MAC IN L.A.
The Los Angeles Macintosh Group promotes the exchange of information, offers help to all levels of users, and provides a forum for people to hear about new products from company representatives. Details are available from Eric Anderson, 12021 Wilshire Blvd., #405, West Los Angeles, CA 90025, (213) 392-5697.

● LOGO NEWS OFFERS PEN PALS—The *National Logo Exchange (NLX)* is a newsletter for teachers that covers techniques and philosophies from successful Logo teaching programs. The subscription is $25 in the U.S., Canada, and Mexico for the eight-month school year. The newsletter also provides a Logo Class Penpal Network, which enables both students and teachers to exchange ideas and projects during the school year. To receive an application, send a legal-sized, self-addressed, stamped envelope to the Logo Class Penpal Network at the address below. For details about the newsletter, contact the *National Logo Exchange*, POB 5341, Charlottesville, VA 22905.

● PHOENIX SENDS TELEGRAM—The National Phoenix User Group Newsletter, *CBTelegram*, contains technical support, news from Goal Systems, details about the formation of regional groups, and notes about past conferences. Efforts have been made to raise funds at national events to provide members with biannual meetings. The National Phoenix User Group is funded and operated by users. Goal Systems provides free advertisements, the cost of producing the newsletter, and support for user groups associated with the Phoenix. Send inquiries to the National Phoenix User Group, POB 14623, Cleveland, OH 44114.

● DEC DRIVE
The Association of DEC Professionals (ADP) welcomes interested DEC programmers and system managers as new members for 1985. For information, send your title, model, and operating system for your DEC system along with a self-addressed, stamped envelope to ADP, POB 81045, Atlanta, GA 30366.

● ROBOTIC CONSUMER
A monthly newsletter designed for manufacturing managers, *Robotics Forum: Management Issues in Manufacturing*, addresses issues on manufacturing and industrial robots. Nontechnical, user-oriented articles, covering such topics as fiscal justification and the myth of turnkey systems, assist managers in making informed decisions. The annual subscription fee is $125. For information, contact the editor, Jay Goldstein, *Robotics Forum: Management Issues in Manufacturing*, POB 123, Lorane, OR 97451, (503) 683-4445.

● SLUG IN PULLMAN
The Sanyo Lovers' Users Group (SLUG) is an MS-DOS group designed to provide technical support for users of the Sanyo MBC series in the Moscow, Idaho/Pullman, Washington area. Members can benefit from regular meetings and access to a public-domain software library. Contact Michael Russell, POB 2084 CS, Pullman, WA 99163, (509) 878-1714.

● NEWS FOR MEDICAL SCIENTISTS—The New York University Medical Center Personal Computer Users Group maintains a public-domain software library that specializes in programs of interest to medical scientists. Information on how to access the group's bulletin-board service and library can be obtained by contacting Dr. James Mihalcik, Department of Anesthesiology, University Hospital, 550 First Ave., New York, NY 10016.

● A PAL IN HAL
The Houston Area League of PC Users (HAL-PC) is a group for users of the IBM PC and its compatibles. Benefits include a public-domain software library, a monthly newsletter that includes software reviews, and more than a dozen special-interest groups. Members of the club are in the process of setting up a bulletin-

(continued)

CLUBS & NEWSLETTERS *is a forum for letting BYTE readers know what is happening in the microcomputing community. Emphasis is given to electronic bulletin-board services, club-sponsored classes, community-help projects, field trips, and other activities outside of routine meetings. Of course, we will continue to list new clubs, their addresses and contact persons, and other information of interest. To list events on schedule, we must receive your information at least four months in advance. Send information to BYTE, Clubs & Newsletters,* POB 372, *Hancock,* NH 03449.

board service. Meetings are held at 7:30 p.m. on the first Tuesday of every month at the Radisson Inn in Houston, Texas. The annual dues are $25. For details, write the Houston Area League of PC Users, POB 610001, Houston, TX 77208.

● OSBORNE IN BOULDER
The Boulder Osborne Users Group (BUG), affiliated with the Denver Osborne Group (DOG), offers support to owners of the Osborne through monthly meetings and DOG's monthly newsletter. People interested in portable computers or the CP/M disk operating system are welcome. Meetings are held at 7 p.m. on the second Wednesday of every month in Room 224 of the University of Colorado's Business School Building in Boulder. Contact Bruce Keith, Boulder Osborne Users Group, 715 South 45th St., Boulder, CO 80303.

● PROS ORGANIZE
The Association of Computer Professionals (ACP) is a nonprofit, educational organization designed for the mutual benefit of programmers, software developers, hardware designers, consultants, and other professionals in the microcomputer field. The newsletter, *ACP NEWS$*, contains an exchange of information to promote members' effectiveness and career interests. Contact Sy Bosworth, ACP, Suite 460, 230 Park Ave., New York, NY 10169, (212) 599-3019.

● ILLINOIS USERS HELP
The Champaign County Computer Club (CCCC) meets at 7:30 p.m. on the first Wednesday of every month to support new or experienced users with computers ranging from Apple to Zenith. Members benefit from special-interest groups, computer classes, a constantly updated public-domain software library of DOS and CP/M disks, and a monthly newsletter. The $12 annual dues also include access to a 24-hour bulletin-board service at (217) 359-9577. Contact Jim Mullen, 1004 Kinch, Urbana, IL 61801, (217) 344-2178.

● SPECIAL SIG
The Gila Valley Apple Growers Association operates a free voice help line for users of the Applewriter IIe at (602) 428-4073. For information, write to the Gila Valley Apple Growers Association, POB 809, Thatcher, AZ 85552.

● A ROOM WITH TERMINALS—The Stanford/Palo Alto Users Group for the IBM PC meets at 7 p.m. on the last Wednesday of each month in Polya Hall, the computer science auditorium of Stanford University. Members can see demonstrations on the terminals at each desk. The club maintains a public-domain software library, produces a monthly newsletter, and opens its membership to the community. The annual fee is $25. Write to the Stanford/Palo Alto Users Group for the IBM PC, POB 3738, Stanford, CA 94305, (415) 326-7006.

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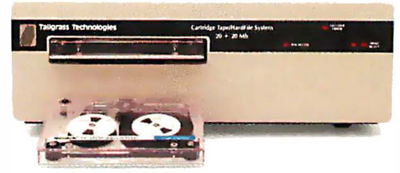
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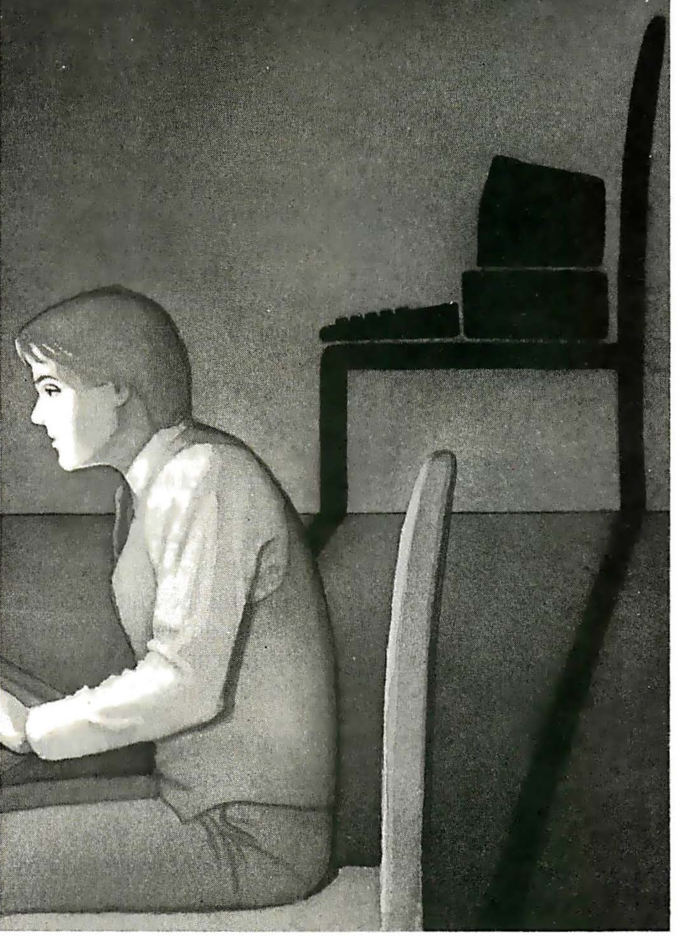
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THE SECOND SELF:
COMPUTERS AND THE
HUMAN SPIRIT
Sherry Turkle
Simon & Schuster
New York: 1984
362 pages, $17.95

INFORMATION SYSTEMS
SECURITY
Royal P. Fisher
Prentice-Hall
Englewood Cliffs, NJ: 1984
240 pages, $24.95

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Reston Publishing
Reston, VA: 1984
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THE SECOND SELF
Reviewed by
Anthony Townsend

The press has focused lately on the novelty of computers, telling us what they are, and will be, capable of doing. We are told that we will see them with increasing frequency in everyday life, and that they will become a greater presence in our work and play. Rare, though, is the article or study of how computers are changing our definition of society. While sociological studies obviously take longer to research and compile than feature articles, they are no less important to the public's understanding of computers as a social force.

In *The Second Self: Computers and the Human Spirit*, Sherry Turkle, a sociologist and psychologist at the Massachusetts Institute of Technology, attempts to chronicle the impact of computers on humanity. Using six years of data and observations, she portrays the computer as an unprecedented influence on civilization, a tool that can simulate the process of the human mind.

Turkle begins by discussing the relationships that children form with microprocessor-controlled toys. Her discussions of how children interact with even the most rudimentary electronic toys show insight into how the computer is now commonplace, as television was to a previous generation.

Using children as an initial study group, Turkle explored their concepts of whether or not machines are alive. What is it about computers and electronic toys that gives them that added dimension of life? This theme is carried through the book as the author explores what it means for a person to "think" and whether a machine can be expected to perform the same process or merely mimic it.

Turkle chronicles the experiences of children at a private school where they have almost unlimited access to computers. As part of a research project, the children learned to use computers as a method of expressing themselves. Using these children as case studies, Turkle begins to develop her theory of how people interact with computers, classifying how children and adolescents use the computer. A distinction is made between "soft" and "hard" masters, a description dependent on whether the child uses the computer as an artistic tool or as a technological shortcut to play and fantasy.

In the second part of the book, Turkle focuses on how people who interact daily with computers view them. She writes about personal computer owners, hackers, and people involved in artificial-intelligence research. Although all three groups have diverse reasons for their attachment to computers, Turkle draws parallels among all three. She

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ILLUSTRATED BY JAMES STEINBERG

postulates that computers in general have the capacity to make human beings think about themselves in a different light. This implies a more introspective process where the faculty of thought becomes the vehicle for comparing human reason to the analytical process of a thinking machine. If a machine can think (and Turkle does not imply that this is likely or probable—simply possible), then it is logical that the human race may no longer be at the top of the evolutionary ladder. Humans could boast the dubious distinction of spawning their own successors.

In the book's final section, "Into a New Age," the author ties together the research and hypotheses of the previous sections. She looks at what it may mean to think of a human being as a machine, and how this affects the human soul, psyche, and spirit in a culture where machines are quite often taken for granted. This idea dates from the Industrial Revolution, but *The Second Self* delves into the rationale of such an assumption. The advent of psychoanalysis is compared to research in artificial intelligence. Turkle implies that today's computers and tomorrow's artificial intelligence will beget a new science of the mind.

STUDY IN STYLE

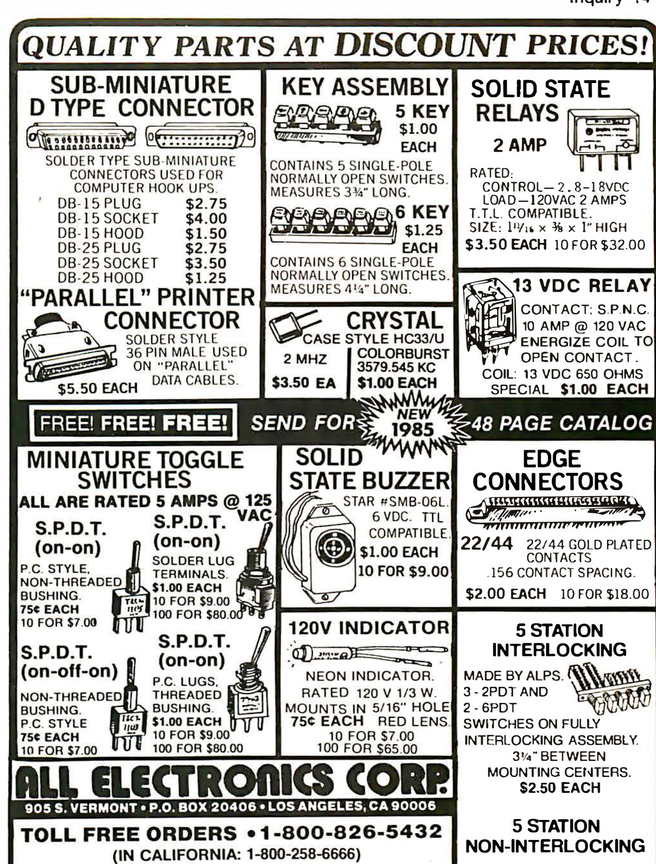
Turkle employs a literary style quite different from the style of other sociological volumes. Quotations from her research subjects are used extensively, and case studies are predominant. She calls her research methods ethnographic, or employing descriptive anthropology. In this context, the word means that her research consisted of exploring the culture she was studying by being present in those groups germane to her work. She uses this particular technique effectively, conveying a real sense of what computers mean to those people involved in their use.

NEW INTERPRETATIONS

The second part of the title, *Computers and the Human Spirit*, perhaps tells the most about what Sherry Turkle is trying to accomplish. Using a unique blend of sociological research and psychological insight, she makes you think about what it means to think. Is the human thought process merely a multilevel collection of chemical processors and instructions? Can something as complex as emotion be reduced to a set series of equations, however complex? Turkle demonstrates that even the abstract activity of thinking about how we think sets us a step beyond a strictly logical perception of consciousness. She hints that computers may have been created prior to a clear understanding of the possible implications.

Turkle frequently refers to Douglas R. Hofstadter's *Godel, Escher, Bach: An Eternal Golden Braid* (Random House, 1980) in formulating her hypotheses on how computers influence and interact with humans. Hofstadter's explanations of esoteric logic have met with wide acceptance among artificial-intelligence experimenters as a kind of symbol that even the most logical proof can be clouded in illogical ramifications. Using the culture of computers and the people involved with them as vignettes of a larger

BOOK REVIEWS



picture, Turkle attempts to reconcile the image of the computer as bound by rules with a freewheeling image of the mind that knows no boundaries. She uses paradox, as Hofstadter does, to stimulate the reader to think that just because an item can be taken for granted does not mean that item is without deeper meaning.

A New Discipline

The Second Self: Computers and the Human Spirit is a book without boundaries. Combining her expertise as sociologist and psychologist, Turkle has created an excursion into thought, a fundamental function of the human race. Authors who use such abstract and undefined parameters in writing usually end up with readers as lost as they were at the start. But Turkle's skill makes it otherwise. Although dealing with subjects as hard to quantify as computers and the human spirit, she does not allow herself to lose sight of the fact that without rational, progressive thought, nebulous concepts become just so much babble.

Because Turkle is a professor in the Science, Technology, and Society Program at MIT; this work may well be the vanguard of a growing branch of science. This young discipline is vital for perspective as computers become more a part of the fabric of human culture. A better understanding of what it means to be human is only one result of further research into this area. Sociologists, psychologists, and philosophers can benefit from examination of the principles put forth by Turkle.

The Second Self is not a book to be read lightly. It requires you to think and respond to its concepts, to postulate what it is that your mind does and how that process is changed by, and is similar to, the electronic parts of machine intelligence. I recommend Turkle's book to anyone who wants a better understanding of themselves and the culture in which they live.

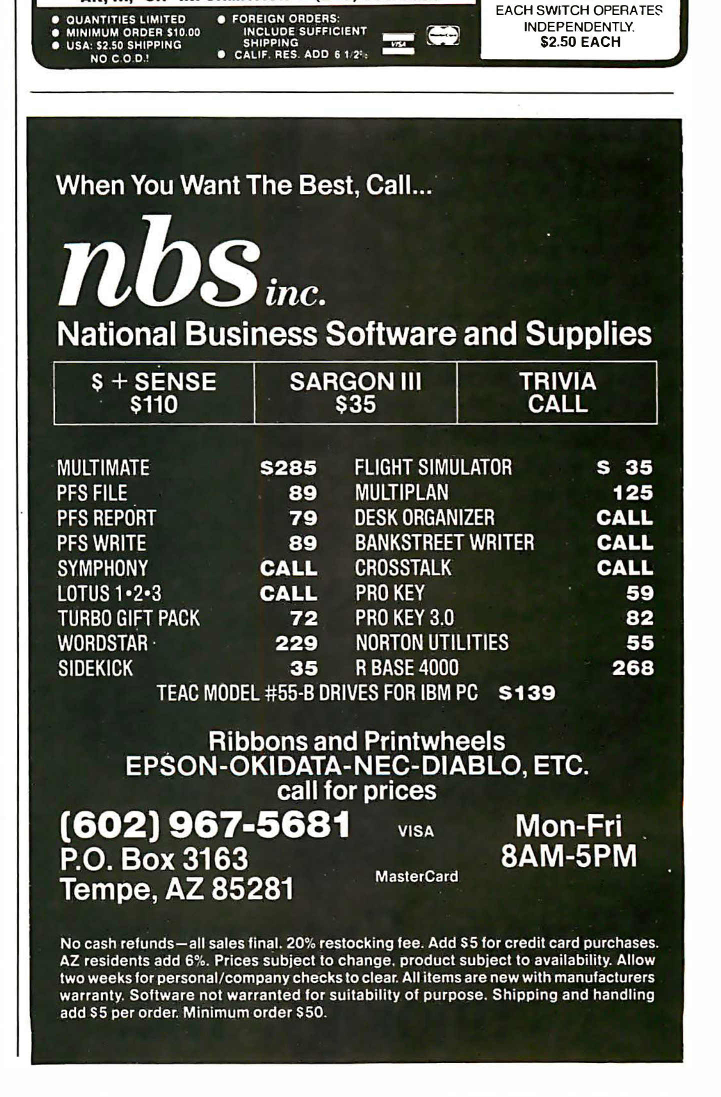
Anthony Townsend (Box 7603, Charlottesville, VA 22906) is an independent microcomputer consultant and software evaluator.

INFORMATION SYSTEMS SECURITY
Reviewed by Annette Hinshaw

Royal Fisher in *Information Systems Security* outlines procedures for managers to discover potential danger spots (exposures) in information systems, develop numerical values for each exposure, and decide which security actions are most cost-beneficial. Examples, worksheets, and charts support straightforward, easy-to-understand explanations of data-security principles. While Fisher uses a mainframe environment as the matrix for his discussion, his techniques can be profitably used by anyone who has information to secure.

Fisher sets out to show managers that data security is a basic business concern, and one that belongs to management as a whole rather than just to managers of data

(continued)



processing. The author broadens the field of concern. In addition to data theft or modification by intruders, managers should also consider data corruption by error a breach of information security. Fisher also emphasizes a need for tested plans to recover vital data that could be lost in disasters such as fire and flood.

Computer security is only one of the information-security issues the author addresses. A businessperson whose vital data is mostly on paper can utilize the systems proposed in this book as readily as someone working in a large data-processing center.

Fisher defines data security as "the protection of data from unauthorized *disclosure, modification* and/or *destruction* whether accidental or intentional." He develops this definition into a classification system for types of exposures. This classification is the first of many practical tools suggested by the author for analyzing potential data-security problems.

The Procedure

The first step in developing an effective information-security system is to draw a flowchart of the data life cycle. In a payroll application, for example, data is generated from workers' time cards, which are physically moved, checked, and entered into the data system. The data completes the cycle when the workers receive their paychecks. Every data-transfer point from time card to paycheck is a potential source of disclosure of privileged information, error, or fraud.

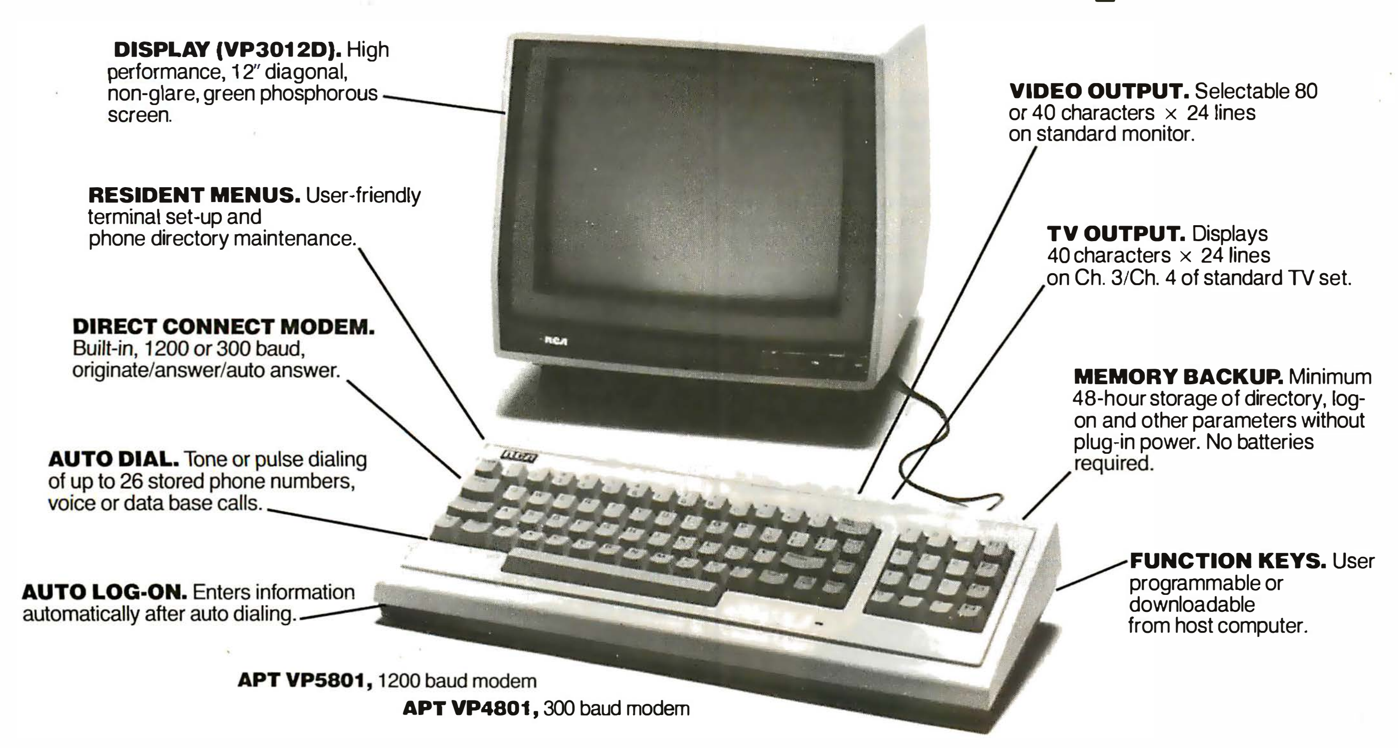
With a complete flowchart, a manager can divide information security into manageable chunks called control points, which can then be handled as separate entities. Fisher's systems are not precise because they do not attempt to map real-world interactions between the modules. However, the complexity of such interactions can easily obscure system analysis. What Fisher's procedures lose in precision they make up for in manageability. The author points out this and other limits in his procedures, which are meant to guide decisions rather than dictate action.

Building information security begins with an analysis of the risks at each control point in the data life cycle, the author says. Considering each type of security exposure (accidental or intentional data disclosure, change, or loss), the analyst identifies the specific exposures for each data-transfer area. He completes a worksheet for each control point and summarizes the risks on another form that maps the data-security system and highlights the greatest risks to information security. Fisher has designed formats for these worksheets.

In a brief chapter, "Limiting Risk," the author reviews a few commonsense, inexpensive ways to improve data security. Fisher shows that careful data-handling procedures in the hands of cooperative employees can eliminate as many potential risks as can elaborate, expensive security designs. Fisher places this chapter between

(continued)

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Inquiry 299

"Identifying Exposures" and "Risk Analysis." I can't help but wonder if the chapter is meant to reassure those managers who are shocked at the number of exposures in their systems and concerned about the cost of correction.

The goals of risk assessment are to rank security exposures and assign numbers (costs per possible loss, estimated number of events) to identified data-security exposures. Fisher presents two methods for evaluating a potential loss, neither of which requires special math skills. He outlines the advantages and limits of each. The results of risk analysis are mapped on a grid that distributes exposures by type and potential loss.

The author's insistence that problems can be reduced to numbers and compared more or less objectively is one of the strongest points in his system for handling information security. Every action he recommends is rooted in realities. He never lets managers lose sight of the fact that breaches of data security are potentially losses, but he emphasizes that correction of such breaches should not cost more than the potential losses. He provides rules of thumb for getting numbers, evaluating the validity of the numbers, and making decisions based on the numbers throughout his process.

Fisher does not discuss specific hardware or software control systems. Rather, he divides controls into preventive, detective, and corrective types and discusses the philosophy of control. However, his approach is not at all abstract; he provides concrete examples on each point. His examples are so successful that many people may read this part of the book and not realize they have absorbed principles instead of facts.

In an extensive table, Fisher analyzes data-security features available in IBM products. The reader can extract a checklist of possible security controls from this table. Appendix C is an effective checklist that defines application controls.

The book addresses the making of cost-effective decisions for installing controls. The major factors in the process, the author says, include estimated potential loss from an exposure, estimated cost of proposed controls to prevent the loss, and estimated probability of the success of those controls. Fisher provides formulas for using these factors to determine "return on investment" for proposed controls. Filling out the selection worksheet for all the exposures in a system gives managers numbers for deciding to install or redesign controls or to accept a given risk as too costly to correct.

In two chapters, Fisher explains a highly detailed analysis and selection process that should cover even the largest computer system. For readers who need just a fast assessment of their security system, the author outlines an abbreviated approach. He assumes that the reader understands the concepts of previous chapters. This version uses a worksheet for each control point and for each likely exposure type at that control point. An analyst fills out the

(continued)

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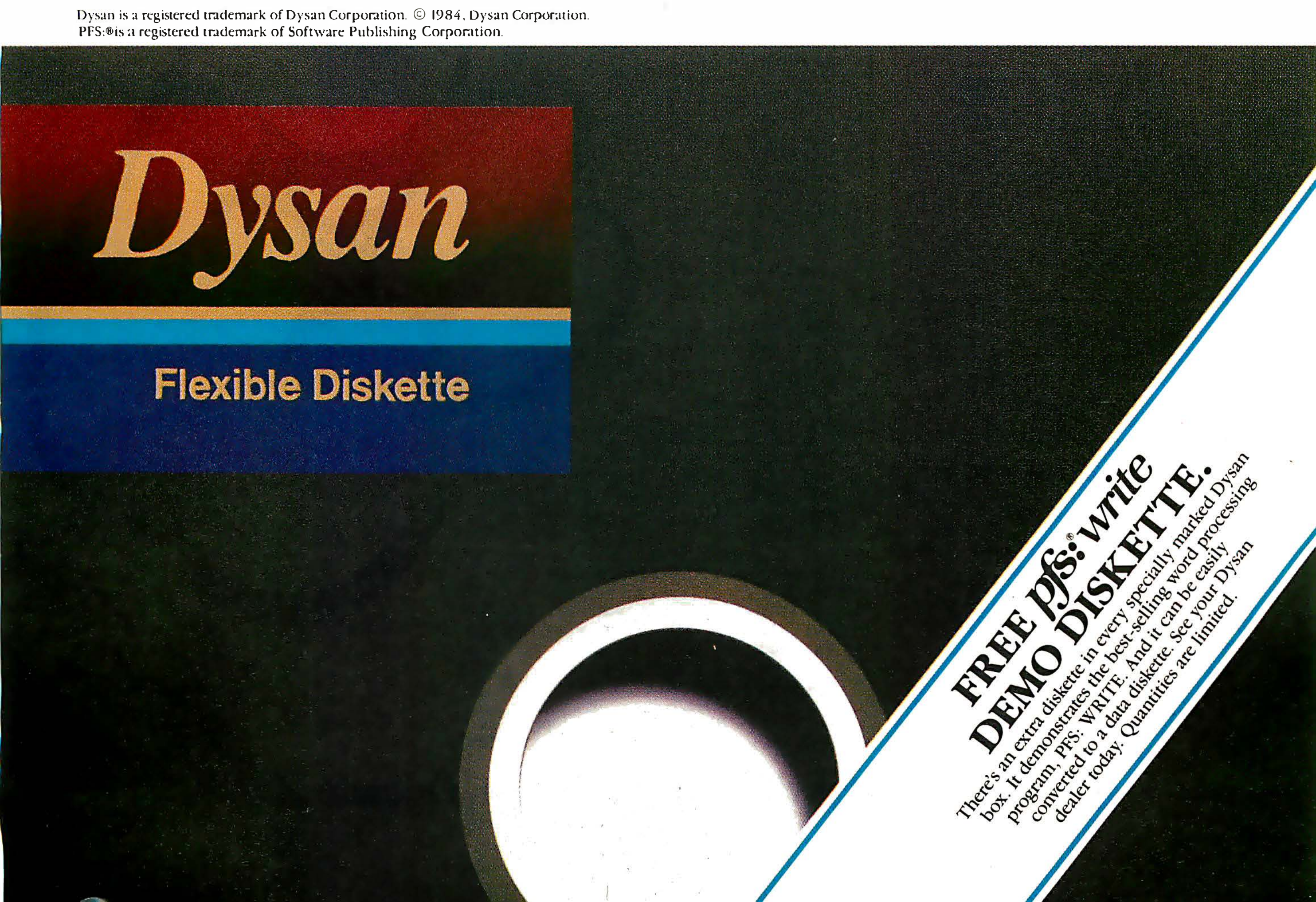
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BOOK REVIEWS

sheets and evaluates the degree of control for that exposure on a 0–4 scale. A summary sheet uses these grades to map strong and weak points in the system and to average a grade for security control in the system as a whole.

Almost half of *Information Systems Security* is appendix. The author reprints questionnaires and guidelines on information-system security from IBM and other companies. The appendixes demonstrate that Fisher's ideas are not original. His contribution is that he gives managers practical methods for assessing risk, evaluating controls, and making decisions on new controls for data security. The appendixes are valuable in light of Fisher's methodical approach to dealing with security systems. Once a manager absorbs Fisher's methods, these appendixes become intermediate readings for further study.

Information Systems Security is not exciting or original, but it is competent and readable for managers who are not computer people. Fisher presents a "can-do" framework for a comprehensive introduction to the principles of developing information security. Managers will still have to determine specific control solutions for their information systems, but they can do so from solid points of departure and with methods they can translate into effective data-security decisions.

Annette Hinshaw (POB 580635, *Tulsa*, OK 74158) *is a freelance technical writer.*

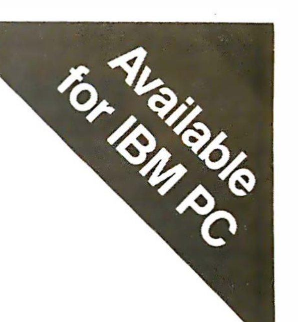
MICROPROCESSORS: HARDWARE, SOFTWARE, AND DESIGN APPLICATIONS

Reviewed by Alan Finger

Given the importance of microprocessor courses in today's engineering curriculum, it is natural that many textbooks have been written on the subject. *Microprocessors: Hardware, Software, and Design Applications* is one example. Its intent is to introduce junior and senior engineering students to the fundamentals of modern microprocessors and the microcomputer systems and software built around them. Wunnava Subbarao is an associate professor at Florida International University and has based this text on his courses there. He examines five well-known microprocessors and illustrates their applications with student projects. This practical approach is well suited to motivating students as well as giving them a hint as to what awaits them in the Real World.

Subbarao begins with an introduction to the general concepts of microprocessors. Other chapters are split into two sections on each device: Intel's 8085, Motorola's 6800, MOS Technology's 6502, Zilog's Z80, and RCA's 1802. The first section on each chip describes the processor and, except for the Z80, a commercial single-board "training" microcomputer using the device. In the second section, the author details several practical applications developed

(continued)



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by students. Although I might quibble with the timeliness of the author's choices of processors and examples, which seem to be governed by what was on hand, they are certainly adequate for an introduction.

Two Points of View

To review this book, I approached it from two perspectives. First, I put myself in the position of an engineering student with a limited knowledge of the subject matter. I would have had courses in digital design and probably an introduction to programming by way of one or two high-level languages. A good textbook should lead me, step by step, through the concepts involved in the design of microcomputer systems and software with appropriate problems to verify my understanding of the material.

I also examined the book as an expert, checking the quality and accuracy of the text and illustrations. Unfortunately, from both viewpoints, *Microprocessors* fails.

An Introduction?

For students, the trouble starts right in chapter 1. The author plunges into a discussion of the internal contents of a "typical" microprocessor and then goes on to a description of address, data, and control buses, and instruction formats. Only after all this are we treated to one diagram and a half page of text as an overview of microcomputer-system organization.

The remainder of the book continues similarly. The chapters discussing the 8085 and its cousin, the Z80, are illogically separated by the very different 6800 and 6502, which are somewhat related to each other. Subbarao makes only a vague attempt to relate any processor to the others. Instruction sets are presented as poor reproductions of the manufacturer's summary sheets—usually pasted to the wall by an experienced programmer as a memory jogger.

The book creates an overall impression of topics strewn haphazardly. What organization there is is counterproductive because it lacks purpose. General system concepts such as system clocks, bus cycles, design rules, and assembly-language programming procedures are ignored in favor of more specialized information on such topics as commercial interconnection schemes (S-100 bus and Multibus) and rarely used components. It seems to this reviewer that the author paraphrased manufacturers' data sheets and student reports.

The material is oriented toward hardware; software design concepts are not discussed. The software portions of the design examples are presented in a "pseudoassembly language" used to hand-assemble code, something I haven't seen in 10 years. The explanations relate only to the hardware "bit-twiddling" aspects of the programs.

Adding to the Confusion

If a student does absorb information from this book, much of it will be wrong. Although it hardly seems necessary,

(continued)

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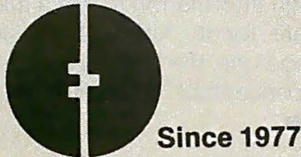
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a number of pages on single-chip microcomputers are thrown in at the end of several chapters. In one such case, Intel's 8048 is incorrectly described as a modified version of the 8085. They do not even belong to the same family. Another error exists in the description of how the 8085 responds to its interrupt input INTR. According to the author's description, the 8085 responds to INTR by issuing an interrupt-acknowledge signal $\overline{INTA}$ to a requester, which, in turn, places the vector address on the data bus. In reality, the 8085 will accept the next complete instruction, usually a 1-byte restart (RST) or 3-byte CALL from the requester. Trying to bring up an interrupt-driven system with information like this would certainly prove interesting.

Much of the misinformation is more subtle. Subbarao uses microcomputer jargon, usually with little or no explanation. He uses much of it incorrectly. The term "bus," for example, has two meanings. It can be used in reference to a collection of related signals connecting different components within a microcomputer system. It can also refer to any of a number of industry-standard arrangements for interconnecting function boards in a larger system. The second type generally contains several of the first type along with other signals. In several instances, the author discusses them as if they were the same. The IEEE-488 (GPIB) bus somehow finds its way into one of these discussions, even though it is actually a data-communications standard generally used to connect a computer to instruments (and occasionally intelligent peripherals such as disk systems and plotters). I would presume its inclusion is due to the presence of the word "bus." The author uses another term, "I/O [input/output] bound," to refer to something "bound for input or output" as opposed to its normal usage as a reference to a program with its speed limited by I/O operations.

Good Problems

If the book has one saving grace, it is the abundance of examples and problems, many of which are accompanied by answers that provide better information than the body text. After reading the chapters on the 1802 processor, with which I am not very familiar, I was still in the dark about many aspects of its operation. I then worked through some of the problems with an RCA data book at hand and felt much more comfortable about the possibility of dealing with one of these rather arcane devices. Perhaps this is what this book is all about: providing problems to be solved using other sources of information.

Subbarao wisely suggests that readers consult the appropriate manufacturer's literature. This book will not provide the student with enough information to use a microprocessor or write software for it. Although the idea behind *Microprocessors* is a good one, the book is too flawed with organizational and conceptual errors for me to recommend it to anyone. ■

Alan Finger is a vice president at Comprehensive Computer Consultants (270 Littleton Rd., Building 14, Westford, MA 01886).



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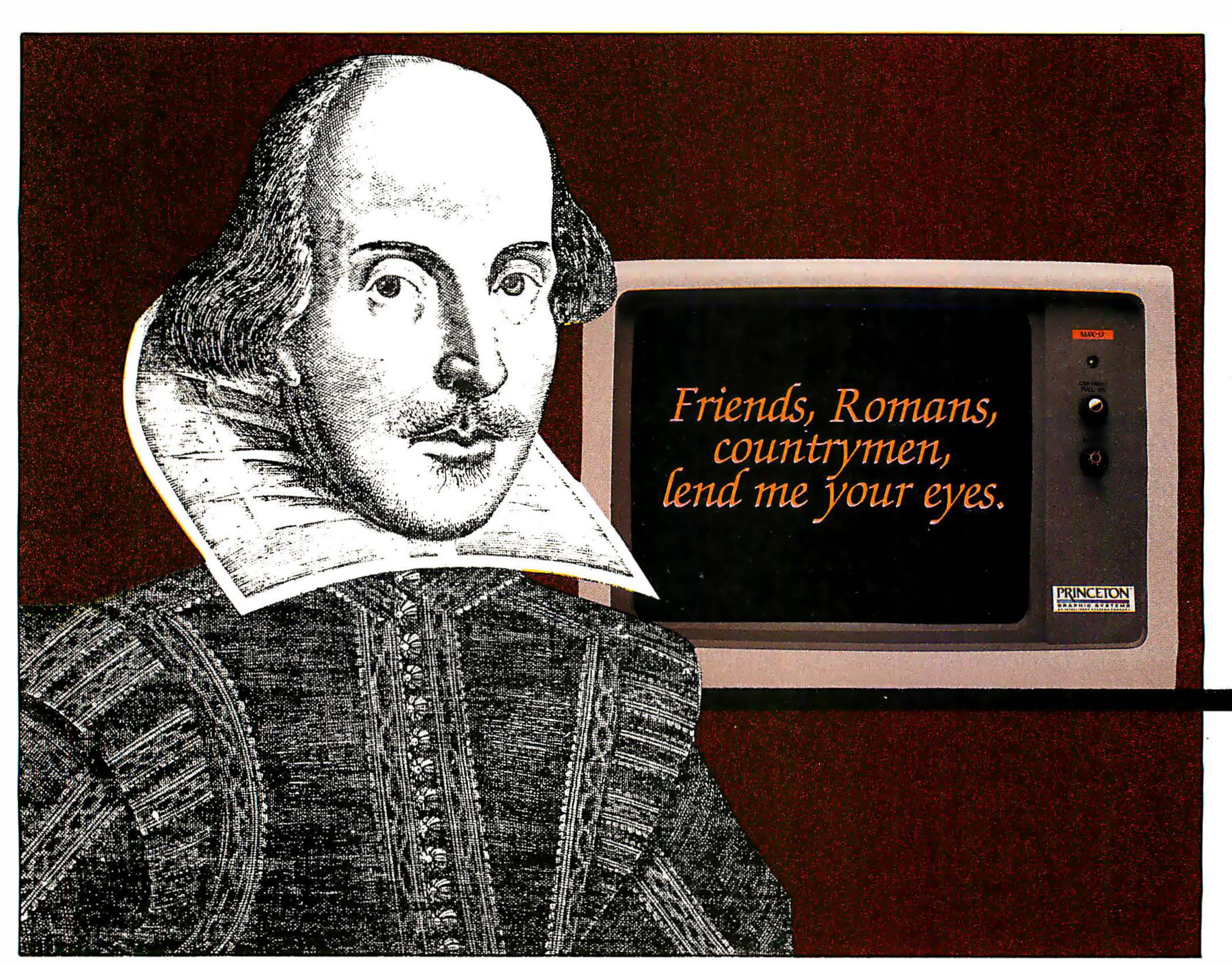
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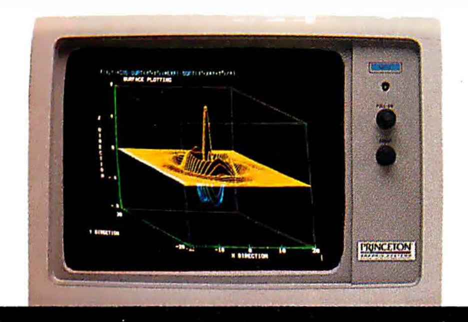
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January 1985

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● NETWORK TROUBLESHOOTING—A Troubleshooting Guide to Supporting and Maintaining the Data Communications Network, various sites throughout the U.S. This seminar outlines a systematic approach to network maintenance methods and procedures, presents specific troubleshooting techniques, and explains software tools. For more information, contact Data-Tech Institute, Lakeview Plaza, POB 2429, Clifton, NJ 07015, (201) 478-5400. *January–February*

● PROCESSING FUNDAMENTALS—Fundamentals of Data Processing for Administrative Assistants and Secretaries and Fundamentals of Information Processing for Nontechnical Executives, various sites throughout the U.S. Two-day seminars. Contact New York University, School of Continuing Education, Seminar Center, 575 Madison Ave., New York, NY 10022, (212) 580-5200. *January–March*

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● BUSINESS COMMUNICATIONS—The Second Annual Business Telecommunications Exposition: BizTelCom Northeast, Aspen Hotel-Manor, Parsippany, NJ. Seminars and product displays. Preregistration is complimentary; $10 at the door. Contact Michael C. J. Houston, T. E. G. Inc., The Exposition Group, 83 Barnegat Blvd., Barnegat, NJ 08005, (609) 698-7020. *January* 16–18

● MEASUREMENT SCIENCE Measurement Science Conference, Marriott Hotel, Santa Clara, CA. Technical sessions will explore such topics as laser and optical-fiber metrology, time and frequency measurements, and the effects of data networks on calibration. Exhibits and formal addresses highlight this event. Registration details are available from Darlene Diven, Measurement Science Conference, POB 61344, Sunnyvale, CA 94088-1344, (408) 756-0270. *January* 17–18

● C WORKSHOP C Programming Workshop, Raleigh, NC. Contact Suzanne B. Battista, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770. *January* 21–25

● IN-FLIGHT COMPUTING EXPLORED—Meeting of the Radio Technical Commission for Aeronautics, Washington, DC. An industry committee will look into the possible effects that battery-operated portable computers may have on an airplane's navigational equipment. The committee, called SC-156, meets at 9:30 a.m. Contact the Radio Technical Commission for Aeronautics, Suite 500, 1425 K St. NW, Washington, DC 20005. *January* 22–23

● MICROS, COMMUNICATIONS, AND BUSINESS Microspeak '85, San Francisco, CA. This conference will focus on ways to set up a cost-effective microcomputer communications system. The fee is $695. Contact Stephen J. Schneiderman, Micro Communications, 500 Howard St., San Francisco, CA 94105, (415) 397-1881. *January* 22–24

● SEMICONDUCTOR EQUIPMENT, CONFERENCE Advanced Semiconductor Equipment Exposition and Technical Conference, Convention Center, San Jose, CA. Admission to the show is free with preregistration. Contact Joyce Estill, ASEE '85 Show Manager, Cartlidge & Associates Inc., 1101 South Winchester Blvd. #M259, San Jose, CA 95128, (408) 554-6644. *January* 22–24

● TECH CONFERENCE, TUTORIALS—USENIX Association Technical Conference and Tutorials, Fairmont Hotel, Dallas, TX. Contact USENIX Conference Office, POB 385, Sunset Beach, CA 90742, (213) 592-1381. *January* 23–25

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(continued)

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courseware, how to evaluate courseware, and how to select and use courseware directories, clearinghouses, databases, and published reviews. Hands-on experience is provided. The fee is $125. Contact Educational Testing Service, Princeton, NJ 08541, (609) 734-1108. *January 24*

● INFO ON TELECOMM
Finding Telecommunications Information, AMFAC Hotel, Burlingame, CA. This seminar explains how to find and stay up-to-date with information on the telecommunications industry. For seminar details, contact Christopher Sterling at (202) 676-8243. For registration details, contact Phillips Publishing Inc., Suite 1200 N, 7315 Wisconsin Ave., Bethesda, MD 20814, (301) 986-0666. *January 28–29*

● FAULT-TOLERANT DESIGN—Introduction to Fault-Tolerant Microcomputer Systems, Sheraton Mockingbird Hotel, Dallas, TX. This course introduces attendees to various topics in fault-tolerant computing, including fault classification, detection, diagnosis, and recovery; error correction and detection; microprocessor testing; and redundancy techniques. The fee is $650. Contact William C. Dries, University of Wisconsin-Extension, Department of Engineering & Applied Science, 432 North Lake St., Madison, WI 53706, (800) 362-3020; in Wisconsin, (608) 262-2061. *January 28–30*

● INSTRUCTIONAL COMPUTING CONFERENCE
The 1985 Florida Instructional Computing Conference, Sheraton Twin Towers Convention Center and Howard Johnson's Florida Center Hotel, Orlando, FL. This fifth annual conference will feature more than 100 sessions on instructional and administrative computing as well as general conference sessions. More than 130 companies will exhibit. Contact the Florida Department of Education, Educational Technology Section, Knott Building, Tallahassee, FL 32301, (904) 487-3104. *January 28–31*

● ADVANCED C TOPICS
Advanced C Topics Seminar, Raleigh, NC. Contact Suzanne B. Battista, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770.
January 28–February 1

● GERMAN TRADE SHOW
Micro-Computer '85, Hall #4, Fairgrounds, Frankfurt, West Germany. More than 200 exhibitors of hardware, software, accessories, and services will display their wares. Other features include seminars, workshops, and discussions. Contact Mr. Philippe Hans, German American Chamber of Commerce, 21st Floor, 666 Fifth Ave., New York, NY 10103, (212) 974-8856.
January 29–February 3

February 1985

● COMPUTER COURSES
Courses from Integrated Computer Systems, various sites throughout the U.S. Among the courses to be offered are "Digital Image Processing" and "Modern Pattern Recognition Systems." Course fees are $945. Contact Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, POB 45405, Los Angeles, CA 90045, (800) 421-8166; in California, (800) 352-8251 or (213) 417-8888; in Canada, (800) 228-6788.
February–March

● LANGUAGE COURSES
Courses from The Micro-

Engine Company, Johannesburg, Republic of South Africa. Courses in UNIX, C, and Pascal are offered. Contact Laurie Butgereit, The MicroEngine Co. (Pty) Ltd., POB 78992, Sandton, 2146, Republic of South Africa, (011) 789-1736.
February–March

● SPECIAL EDUCATORS
Computers & Reading/Learning Difficulties, Third Annual Western States Conference, Los Angeles, CA. Sixty presentations and hands-on workshops will explore the use of computers in reading, language arts, and learning difficulties. Educational materials will be exhibited. Workshop fees are $55, and conference fees are $55 and $95. Contact Educational Computer Conferences, 1070 Crows Nest Way, Richmond, CA 94803, (415) 222-1249.
February 1–2

● AUTOMATED FACTORY EXPLORED—Automated Manufacturing, Don CeSar Hotel, St. Petersburg, FL. Contact Eleanor Bernet, Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080.
February 4–5

● TECHNOLOGY AND THE OFFICE—The 1985 Office Automation Conference, Georgia World Congress Center, Atlanta, GA. The theme for the sixth annual Office Automation Conference is "Today's Partnership: People and Technology." More than 45 technical sessions are planned. Full-conference preregistration fees are $100, which includes admission to the exhibit area. Student, one-day, and exhibit-only rates are $10, $40, and $30, respectively. Full-conference registration at the door is $125. Contact OAC '85, American Federation of Information Processing Societies Inc., 1899 Preston White Dr., Reston, VA 22091, (703) 620-8952.
February 4–6

● PROLOG INSTRUCTIONS
Prolog Workshop, New York City. A hands-on program in Prolog, running under UNIX. Subjects covered include the fundamentals of logic programming with Prolog, artificial intelligence representation techniques, and expert system design. Participants should be familiar with a high-level language. Contact Keith Eisenstark, Structured Methods Inc., 7 West 18th St., New York, NY 10011, (212) 741-7720.
February 4–7

● SIMULATION AND MODELING—Simulation and Modeling with SIMSCRIPT II.5, Westpark Hotel, Arlington, VA. This course serves as an introduction to the concepts of simulation and model building using SIMSCRIPT II.5, a programming language tailored for simulation analysts, model builders, engineers, and computer scientists. The fee is $850. Contact Ed Russell, CACI, 12011 San Vicente Blvd., Los Angeles, CA 90049, (213) 476-6511; on the eastern seaboard, call Carl Joeckel, (215) 628-3701.
February 4–8

● MANUFACTURING EXPO
Florida Computer Manufacturing Expo, Centroplex Expo Center, Orlando, FL. Hardware, software, peripherals, and accessories will be displayed. A seminar program is planned. Contact Great Southern Computer Shows, POB 655, Jacksonville, FL 32201, (904) 356-1044. *February* 5–8

● STRIDE TO FAIRE
Stride Faire '85, MGM Grand Hotel/Casino, Reno, NV. This is the second annual technical trade fair sponsored by Stride Micro, formerly

(continued)

EVENT QUEUE

known as Sage Computer. Contact Laura Smith, Stride Micro, 4905 Energy Way, Reno, NV 89502, (702) 322-6868. *February* 8–10

● SOFTWARE MANAGEMENT CONTROL—Configuration Management of Software Programs, San Diego, CA. Intended to show those working in software management how to control development, maintenance, and operational costs. Familiarity with MIL-STD 480, 483, and 490 is helpful, but there is no prerequisite for this course. The cost is $730. Contact Stod Cortelyou, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8520. *February* 11–13

● NETWORK COMPONENTS EXPLAINED
Data Communications Network Components, Atlanta, GA. This course provides a thorough overview of the use, operation, applications, and acquisition procedures of 25 major communications components. The fee is $795. Contact Elaine Hadden Nicholas, Department of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332-0385, (404) 894-2547. *February* 12–14

● INTERACTIVE INSTRUCTION—The Third Conference on Interactive Instruction Delivery, Sheraton Towers Hotel, Orlando, FL. Contact the Society for Applied Learning Technology, 50 Culpeper St., Warrenton, VA 22186, (703) 347-0055. *February* 13–15

● COMPUTERS FILL EDUCATORS' TALL ORDER
The Fifth Annual Conference of the Texas Computer Education Association, Hyatt Regency Hotel, Austin, TX. The theme for this conference is "New Directions for Education Using Modern Day Technology." Contact TCEA Conference, POB 2573, Austin, TX 78768. *February* 13–16

● PC SYMPOSIUM
The 1984 UNM Personal Computer Symposium, University of New Mexico, Albuquerque. The second annual Personal Computer Symposium will feature exhibits, seminars, and demonstrations of personal computer systems of interest to businesspeople, educators, and professionals. Contact the Tau Beta Pi Honor Society, c/o Dr. Randy Truman, Department of Mechanical Engineering, University of New Mexico, Albuquerque, NM 87131, (505) 277-6296. *February* 15–16

● COCO CONVOCATION
Rainbowfest, Irvine Marriott, Irvine, CA. A show for users of the Radio Shack TRS-80 Color Computer. More than 50 exhibitors are expected. Contact Falsoft Inc., POB 385, Prospect, KY 40059, (502) 228-4492. *February* 15–17

● SOFTWARE UPDATE
The Second Annual International Software Update, Waiohai Resort Hotel, Kauai, HI. An international lineup of speakers will focus on domestic and international marketing concerns and future trends in microcomputer software. Attendance is limited. Contact Raging Bear Productions Inc., Suite 175, 21 Tamal Vista Dr., Corte Madera, CA 94925, (800) 732-2300; in California, (415) 924-1194. *February* 16–20

● MICROS FOR EDUCATORS—Association of Teacher Educators National Conference, Riviera Convention and Resort Hotel, Las Vegas, NV. Exhibits and

(continued)



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EVENT QUEUE

demonstrations of microcomputers, microcomputer products, and communications equipment will be featured. Contact Peter C. West, Learning Center, College of Education, Gabel Hall 8, Northern Illinois University, DeKalb, IL 60115, (815) 753-1241.
February 18–19

● MANAGE YOUR COMPUTER—Managing Computer Resources, Wintergreen Learning Institute, Wintergreen, VA. Focuses on networking, system design, performance evaluation, and operational difficulties encountered by managers and executives. Rates include lodging and ski-lift tickets and vary from $570 to $769 depending on accommodations. Contact Dr. M. D. Corcoran, Wintergreen Learning Institute, POB 7, Wintergreen, VA 22958, (800) 325-2200; in Virginia, (804) 325-1107.
February 18–22

● DIGITAL USERS MEET DECUS Canada Spring Symposium, L'Hotel, Toronto, Ontario, Canada. This symposium covers a variety of topics of interest to Digital computer users. Contact Jeanne McNeish, DECUS, 100 Herzbug Rd., POB 13000, Kanata, Ontario K2K 2A6, Canada, (613) 592-5111, ext. 2782. *February* 19–22

● COMMUNICATIONS FOR EXECS—Info/Central, O'Hare Exposition Center, Chicago, IL. This show and conference on computers and communications is tailored to the needs of executives and data-processing managers. Mainframes, microcomputers, telecommunications systems, and micrographics are a few of the areas to be addressed. Contact the Show Manager, Info/Central, 999 Summer St., Stamford, CT 06905, (203) 964-8287.
February 20–22

● COMPUTERS IN EDUCATION—The Role of the Computer in Education 5, Arlington Park Hilton, Arlington Heights, IL. A range of topics of interest to educators will be presented. Contact Rick Nelson, The Role of the Computer in Education 5, Micro-Ideas, 2701 Central Rd., Glenview, IL 60025, (312) 998-5065.
February 20–22

● BUSINESS GRAPHICS Computer Business Graphics, Bonaventure Intercontinental Hotel, Fort Lauderdale, FL. Contact Carol Every, Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080.
February 20–23

● MAC IN SPOTLIGHT MacWorld Exposition, Brooks Hall, San Francisco, CA. A hands-on festival of Macintosh hardware, software, and peripherals. Contact World Expositions, Mitch Hall Associates, POB 860, Westwood, MA 02090, (617) 329-7466.
February 21–23

● COMPUTER FAIRE The Fourth Annual IEEE Computer Faire, Huntsville, AL. Sponsored by the Institute of Electrical and Electronics Engineers Inc. For complete information, contact Terry Mizell, POB 5188, Huntsville, AL 35805, (205) 532-2036. *February* 22–23

● FARM AUTOMATION Agri-Mation, Palmer House Hotel, Chicago, IL. This conference and exposition will focus on the role of automation in agriculture. Contact the Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500.
February 25–28

● COMPUTING IN ANESTHESIA—Computing in Anesthesia '85, The Third International Seminar,

Miramar-Sheraton, Santa Monica, CA. Medical and computer specialists will describe their research and use of computers in data acquisition and display, computerized monitoring, instruction, education, database management, and knowledge-based systems. The registration fee is $300. Contact Program Chairman, Computing in Anesthesia '85, Anesthesiology Educational Foundation, Federal Building, POB 24230, Los Angeles, CA 90024, (213) 825-7561.
February 25–March 1

● SHORT COURSE FOR ENGINEERS—Dynamics on Microcomputers, University of Michigan-Dearborn. For information, contact R. E. Little, University of Michigan, 4901 Evergreen Rd., Dearborn, MI 48128, (313) 593-5241.
February 25–March 1

● HIGH-TECH IN FOCUS High-Tech '85 Exhibit and Seminar, Thunderbird Motel, Bloomington, MN. More than 100 manufacturers will exhibit computer terminals, peripherals, data-communications equipment, and digital test instruments. Admission is free. Contact John Bastys or Barb Mueller, Countryman Associates Co., 1821 University Ave., St. Paul, MN 55104, (612) 645-9151. *February 26–27*

● AUTOMATION FOR ELECTRONICS—Automated Design and Engineering for Electronics, Anaheim Hilton and Towers, Anaheim, CA. This conference and exposition covers the use of automation in the design of electronic circuitry. For further details, contact Michael Indovina, Cahners Exposition Group, Cahners Plaza, 1350 East Touhy Ave., POB 5060, Des Plaines, IL 60018, (312) 299-9311.
February 26–28

● MICRO-AIDED MANAGEMENT—Microcomputer-aided Maintenance Management System, Ramada Inn, Airport, Milwaukee, WI. This course is designed to show how computers can help improve the maintenance functions of any organization. The fee is $60. Contact Unik Associates, 12545 West Burleigh, Brookfield, WI 53005, (414) 782-5030.
February 27

March 1985

● FOSE SOFTWARE SHOW Federal Office Systems Exposition (FOSE) Software '85, Convention Center, Washington, DC. Four days of workshops, symposia, and exhibits of software. Contact Rosalind Boesch, National Trade Productions Inc., Suite 400, 2111 Eisenhower Ave., Alexandria, VA 22314, (800) 638-8510; in Virginia, (703) 683-8500. *March 4–7*

● MINI/MICRO Mini/Micro Southeast-85, Georgia World Conference Center, Atlanta. A conference and exposition. Contact Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.
March 5–7

● COMPUTER, COMMUNICATIONS SECURITY SECURICOM '85: The Third World Congress on Computer and Communications Security and Protection, Palais des Festivals et des Congrès, Cannes, France. Topic areas include electronic banking security, security implications of new media, security within microcomputers and distributed systems. Contact SEDEP, Expositions Department, 8, Rue de la Michodiere, 75002, Paris, France; tel: 742 41 00; Telex: 250303

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EVENT QUEUE

PUBLIC X PARIS.
March 6–8

● INDUSTRIAL AUTOMATION—AUTOTECH Hong Kong '85, Hong Kong. An international conference on industrial automation held in conjunction with the First Exhibition on Automation Technology. The theme is "Micros in Affordable Automation—Creating New Industrial Opportunities for All." Contact Hong Kong Productivity Centre, 12th Floor, World Commerce Centre, Harbour City, 11 Canton Rd., Tsimshatsui, Kowloon, Hong Kong; tel: 3-7235656.
March 7–8

● SUGI CONFERENCE The Tenth Annual SAS Users Group International (SUGI) Conference, Reno, NV. Topics include capacity planning and evaluation, systems software, education, graphics, information systems, and microcomputers. Contact SAS Institute Inc., SAS Circle, POB 8000, Cary, NC 27511, (919) 467-8000.
March 10–13

● CONFERENCE ON SCIENCE—ACM Computer Science Conference, Marriott Hotel, New Orleans, LA. This conference, sponsored by the Association for Computing Machinery and a number of college and university computer science departments, features an employment register, whereby job seekers can meet prospective employers. Contact ACM Computer Science Employment Register, Department of Computer Science, University of Pittsburgh, POB 13526, Pittsburgh, PA 15234.
March 11–14

● DESIGN SHOW The 1985 National Design Engineering Show, McCormick Place, Chicago, IL. More than 600 CAD/CAM system and electronic component companies will exhibit products. Contact the Show Manager, National Design Engineering Show, 999 Summer St., Stamford, CT 06905, (203) 964-0000.
March 11–14

● SCSI SEMINARS Small Computer Systems Interface (SCSI) Forum, Houston, TX. Seminars and exhibits of SCSI controllers and related peripherals. Contact Mr. J. Molina, SCSI Forum Ltd., POB 2625, Pomona, CA 91768-2625.
March 12

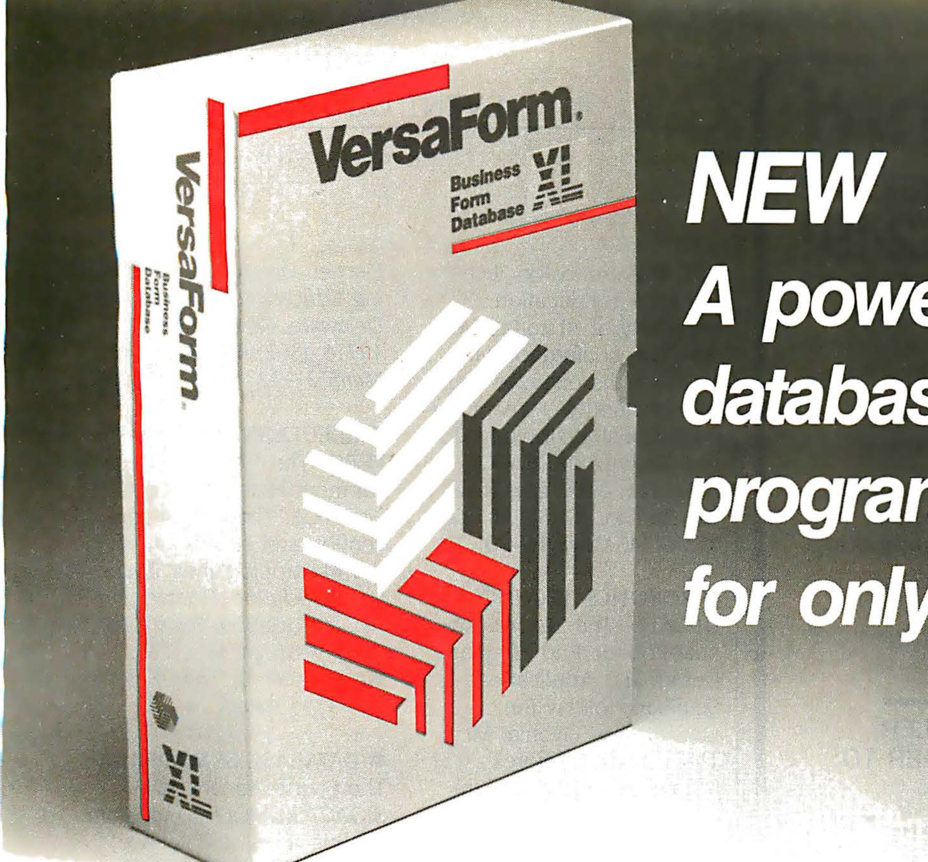
● EDUCATIONAL CONFERENCE—The 1985 Microcomputers in Education Conference, Arizona State University, Tempe. The theme is "Tomorrow's Technology." Emphasis will be placed on integrating computer technology and languages into the educational environment. Contact Donna Craighead, Payne B47, Arizona State University, College of Education, Tempe, AZ 85287, (602) 965-7363. *March 13–15*

● SIMULATION IN SUNSHINE—The Eighteenth Annual Simulation Symposium, Tampa, FL. A forum for interchange of ideas, techniques, and applications among those working in this field. Contact Alexander Kran, IBM Corp., East Fishkill Facility, Hopewell Junction, NY 12533.
March 13–15

● COMPUTERS AND TELECOMMUNICATIONS COMTEL '85: International Computer and Telecommunications Conference, Infomart, Dallas, TX. Contact COMTEL '85, Suite 600, 13740 Midway Rd., Dallas, TX 75244, (214) 458-7011.
March 18–20

● TECHNOLOGY AND EDUCATION—The First An-

(continued)



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EVENT QUEUE

nual Conference on Technologies in Education, University of Arizona, Tucson. This conference will focus on the effective implementation of research in educational technology. Contact Steve Louie, NACCIS, Suite 125, 2200 East River Rd., Tucson, AZ 85718, (602) 323-6144. *March* 18–20

● ROBOTICS TECHNOLOGY UPDATE—The Second Annual Robotic End Effectors: Design and Applications Seminar, Holiday Inn Livonia-West, Livonia, MI. This seminar explores robotic end effector techniques, sensors for tooling, compliant devices, interchangeable end-of-arm tooling devices, multihand tools, and magnets for tooling. More than 25 companies will exhibit. Contact John McEachran, Special Programs Department, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500, ext. 382. *March* 19–20

● AI FOR ROBOTS Aircon 2: The Second Annual International Conference on Artificial Intelligence for Robots, Stouffers Concourse in Crystal City, Arlington, VA. This conference is designed to promote a dialogue between experts and users of artificial-intelligence systems. The theme is "Toward Intelligent Robots: The Droids Are Coming." Contact Cindy Mega, IIT Research Institute, 10 West 35th St., Chicago, IL 60616, (312) 567-4024. *March* 21–22

● ELEMENTARY COMPUTING—University of Delaware Second National Conference: Computers and Young Children, University of Delaware, Newark. The emphasis is on programs for children 4 to 8 years old. Contact Dr. Richard B. Fischer, Division of Continuing Education, University of Delaware, Newark, DE 19716, (302) 451-8838. *March* 21–22

● ELECTRONIC TRANSFERS—The 1985 EFT Expo, Fairmont Hotel, San Francisco, CA. The annual convention and exposition of the Electronic Funds Transfer Association. Contact the EFT Association, Suite 800, 1029 Vermont Ave. NW, Washington, DC 20005, (202) 783-3555. *March* 24–27

● DATABASE SYMPOSIUM The Fourth Annual ACM SIGACT/SIGMOD Symposium on Principles of Database Systems, Portland, OR. This conference covers developments in the theoretical and practical aspects of database systems. Topics include the application of artificial-intelligence techniques to database systems, data models, and data structures for physical database implementation. Contact David Maier, Department of Computer Science, Oregon Grad Center, 19600 Northwest Walker Rd., Beaverton, OR 97006. *March* 25–27

● OPTICAL STORAGE TECHNIQUES—The Third Annual Conference on Optical Storage of Documents and Images, Shoreham Hotel, Washington, DC. For information, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114-0817, (415) 626-1133. *March* 25–27

● WEST COAST FAIRE The Tenth Annual West Coast Faire, Moscone Center, San Francisco, CA. This is one of the largest computer shows. Contact Computer Faire Inc., Suite 201, 181 Wells Ave., Newton Falls, MA 02159, (800) 826-2680; in Massachusetts, (617) 965-8350. *March* 30–*April* 2 ■





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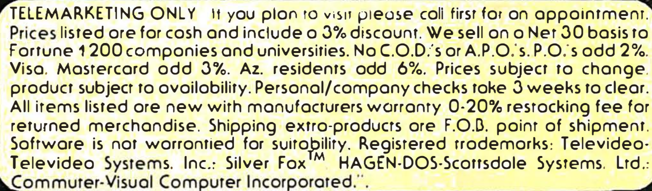
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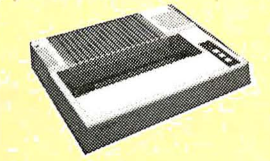
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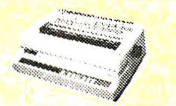
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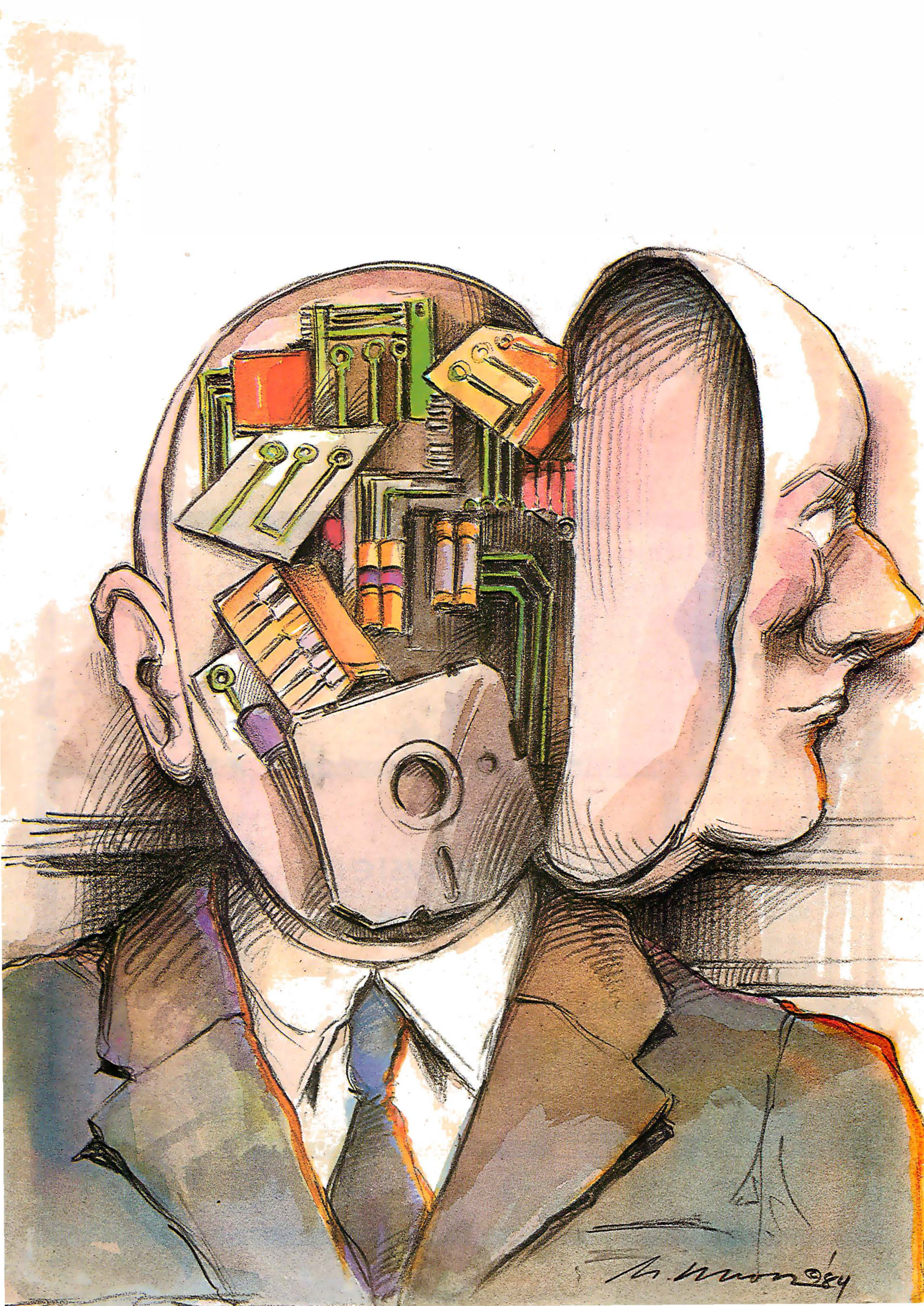
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Features

THE JANUARY ISSUE OF BYTE begins what we hope is another banner year for microcomputer enthusiasts. Artist Robert Tinney has restarted the personal computing hourglass, depicting the inevitable flow of new products and technology that will appear in 1985.

This month we offer an exceptional number and variety of feature articles. As in past January issues, we do not have a theme section; we take this opportunity to publish twice the number of features. We'll return to our normal theme format in February with a section dedicated to computing in the sciences.

To start this month, Steve Ciarcia focuses on an analog topic: power supplies and their attendant problems. If you've wanted a robust 12- to 13.2-V, 15-A power supply made from readily available components, check out Ciarcia's Circuit Cellar.

The pictures-versus-words user-interface debate is likely to continue for some time, but Bill Benzon provides a strong argument for the Macintosh as a tool for the visual brain in "The Visual Mind and the Macintosh."

Speaking of the Macintosh, Gregg Williams, senior technical editor, describes the content and structure of Microsoft's latest version of BASIC for the Mac in "Microsoft Macintosh BASIC Version 2.0." And along with Rob Moore, Gregg continues part 2 of "The Apple Story," which began in the December supplement, *BYTE Guide to Apple PCs*. Also continued from December is part 2 of "An Introduction to Fiber Optics" by Richard Shuford, BYTE's special-projects editor. Richard discusses connections and networks of optical-fiber waveguides.

If you've ever tried "computing in the dark," you'll find William Rynone's "Uninterruptible Power Supplies" enlightening. While not intended to be comprehensive, his article provides a comparison among some commercial units, a do-it-yourself project, and some shopping tips.

New developments in VLSI enable Joseph Nadan to give "A Glimpse into Future Television" and describe how this technology is evolving in parallel with personal computers to bring television into the "information age."

If you do decimal computations on large numbers, read "Algorithms for a Variable-Precision Calculator" by Paul Nilson. He uses a pseudocode to explain the logic in his arithmetic algorithms.

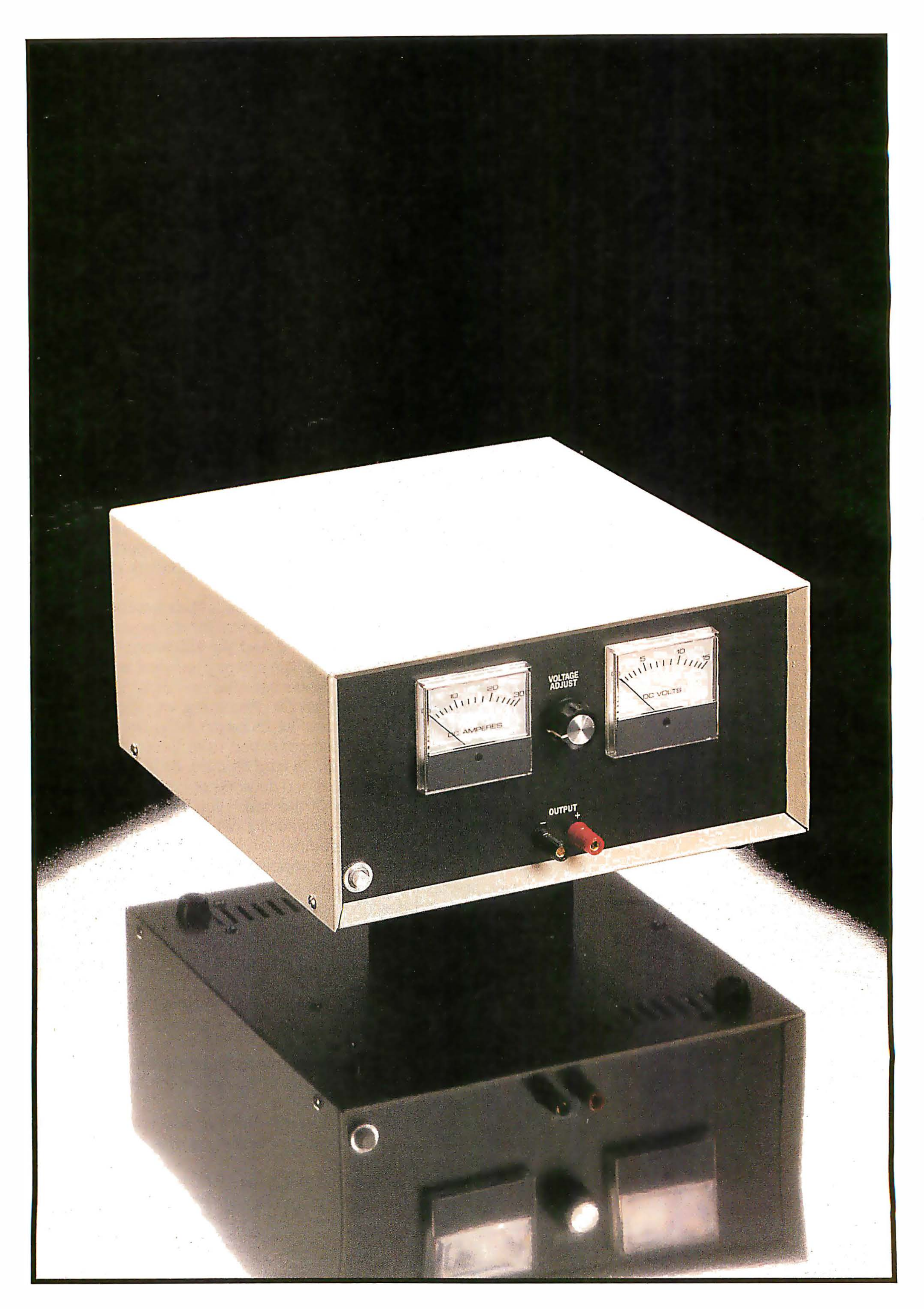
If you have an IBM PC and are interested in charting the frequency response of your lease-breaker stereo system, read Vince Banes's "Audio-Frequency Analyzer" construction article.

A difficult-to-read display based on coarse-resolution dot-matrix letters may be a thing of the past, as described in "Font Design for Personal Workstations" by Charles Bigelow.

In Bruce D'Ambrosio's "Expert Systems—Myth or Reality?" he touches on some of the capabilities and limitations of expert systems and the directions in which researchers are heading.

We've quite a variety of topics in January, and we look forward to a variety of editorial topics and themes in the remainder of 1985.

—Gene Smarte, Managing Editor



PHOTOGRAPHED BY PAUL AVIS

UNDERSTANDING LINEAR POWER SUPPLIES

BY STEVE CIARCIA

Proper design brings simplicity and reliability

Sometimes it is the more trivial aspects of electronics that create the greatest problems. With all the concern about 16-bit versus 32-bit processors and multitasking operating systems, who would think that a simple linear power supply could cause the demise of a company? Even with a board of directors full of venture capitalists, it's often too late when they look beyond their spreadsheet projections and ask whether the product they are financing actually works.

While looking over someone's shoulder is not my favorite consulting activity, I recently was involved in such a situation. One of the founders of a venture-capital-funded company was getting very nervous because his engineering department was seriously overdue on two products. Since his responsibility was sales, and about $800,000 in pending orders was riding on cost-effective delivery of these products, it was no wonder that he was concerned. One of the products was way over budget, and the other seemed to have a "heat problem." My job was to determine if there was a problem and help rectify it if possible.

The first product was a speech synthesizer that attached to a parallel printer port. Its problem was "engineering buzzword injection phenomenon." Inexperienced engineers try to impress management by designing microprocessors into products that don't need them.

The synthesizer chip required parallel data and a strobe. It signified that it needed more data with a single ready line. Instead of merely attaching the chip directly to the printer port and pretending it was a printer (attaching printer busy to the ready line), the engineer had added a mask-programmed microprocessor, external character-buffer memory ("In case the programmer wanted it," he said.), external program memory (in case the mask-programmed chips didn't arrive in time and they had to use EPROMs [erasable programmable read-only memories]), and a parallel port for the synthesizer chip. Direct connection to the printer port (without the microprocessor) afforded a 75 percent cost reduction.

The second product, which I'll call E, was a stand-alone speech-and-music synthesizer board that communicated serially with the host computer. To make a long story short, I was called in to look at E after 5000 sets of

(continued)

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, and product development. He is the author of several books about electronics. You can write to him at POB 582, Glastonbury, CT 06033.

components and printed-circuit boards had been purchased but nothing had been shipped. It was now four months overdue.

I agreed on the basic design method. Because of the data in serial format and multiple peripheral chips, this device did require a microprocessor. Unfortunately, it suffered from another common ailment among inexperienced designers: "three-terminal-regulator narcosis." This occurs when you read the manufacturer's spec sheets on a three-terminal regulator and use the information without understanding it or the other elements in the power supply.

My first experience with the E product almost burned my nose. I leaned over an operating prototype to make a closer inspection and sensed intense heat rising from the power-supply section. According to the designer, everything was within the manufacturer's specifications. The board needed +12 and +5 volts (V) at 0.5 ampere (A), which was regulated down from an 18-V (plus 10 percent ripple) rectifier output. The 90° Celsius (C) case temperature was "warm," but the engineer hotly contested that everything was okay. When further queried about added heat once the unit was enclosed, he assured me that it still wouldn't exceed the manufacturer's specified limit of 150°C (apparently he didn't know the difference between junction and case temperature).

I come from the school of design that says, "If you can't touch it, you've got big problems." Eventually, my greatest fears were realized. E boards were installed in ABS (acrylonitrile-butadiene-styrene) thermoformed plastic cases and allowed to burn in (aptly named) overnight. When inspected in the morning, the tops of many cases had melted and deformed. In addition, many of the regulators had failed and were now inoperable. At this point, the bad design could not be hidden from the venture capitalists. Even marketing concurred, "We can't ship an incendiary device to every kid with a computer!"

Linear Power Supplies

Virtually all electronic equipment operates on a DC power supply. This DC voltage can come from a battery or can be converted from an energy source such as the AC power line. The two commonly used conversion methods are switching and linear.

The advent of easy-to-use three-terminal regulators has given designers a false sense of security. Because of the wide operating limits and built-in protection of many of these monolithic regulators, brute force and a rule-of-thumb design technique can still result in functional power supplies. It takes resourceful and knowledgeable designers who understand the interrelationships of power-supply components to produce efficient and cost-effective products. In the case of E, larger heatsinks or lower input voltages would have offered some after-the-fact relief. Some better understanding of linear power supplies and a bit of initial computation would have resulted in a shippable design in the first place, however.

My Circuit Cellar projects range from the esoteric to the instructive. I do, however, presume that the builders of these projects have a certain level of basic understanding and that many hours of construction won't go up in smoke because of a poorly designed power supply. This recent experience has made me hesitate to be quite so presumptuous, and I will now add linear power supplies to my periodic tutorial subject list (with speech synthesis, home control, etc.).

This month I'll go back to basics and analyze the construction of linear power supplies. I'll describe transformer selection, input-filter design, regulator selection and connection, heatsinking, and layout. I will particularly emphasize the filter, heatsinking, and layout. Most articles seem to

CONFIGURATION	CIRCUIT	V_{IN}	$V_{O(PEAK)}$	AVERAGE V_O DC	PEAK INVERSE VOLTAGE PER DIODE	FUNDAMENTAL OUTPUT RIPPLE FREQUENCY 60Hz	OUTPUT WAVEFORM
V_{RMS} R_L V_O	SINGLE-PHASE HALF WAVE	V_{RMS}	$1.41V_{RMS}$	$\frac{1}{\pi}V_{O(PEAK)}=0.45V_{RMS}$	$1.41V_{RMS}$	$1F_L$	OVDC
V_{RMS} V_{RMS} R_L V_O	SINGLE-PHASE CENTER-TAP FULL WAVE	V_{RMS}	1.41_{RMS}	$\frac{2}{\pi}V_{O(PEAK)}=0.90V_{RMS}$	2.82_{RMS}	$2F_L$	OVDC
V_{RMS} V_O R_L	SINGLE-PHASE BRIDGE FULL WAVE	V_{RMS}	$1.41V_{RMS}$	$\frac{2}{\pi}V_{O(PEAK)}=0.90V_{RMS}$	$1.41V_{RMS}$	$2F_L$	OVDC

Figure 1: *Three single-phase transformer-rectifier configurations.*

overlook these items while they discuss various regulator configurations. If, after building a supply from such a slanted article, the end product is in thermal shutdown most of the time because of naive filter design, you are better off reading comic books. I believe that the construction of power supplies isn't difficult, but perhaps no one has ever described how to do it. Hopefully, the process will become easy after reading this article.

STARTING WITH THE BASICS

Generally speaking, a basic single-phase linear power supply consists of little more than a transformer, rectifier, and filter. Where it is necessary to accurately maintain the output potential, a voltage-regulator circuit is added. More precisely, the four components function as follows:

1. A *transformer* isolates the supply from the power line and reduces the input voltage (120 or 220 V AC) into usable low-voltage AC.
2. A *rectifier* converts the AC to a DC waveform and satisfies the charging-current demands of the filter capacitor.
3. A *filter* capacitor maintains a sufficient voltage level between charging cycles to satisfy the minimum voltage requirements of either the load directly or a voltage regulator attached to the load.
4. A *regulator* maintains a specific output voltage over various combinations of input voltage and load.

The three basic forms of single-phase transformer-filter circuits are half-wave, full-wave bridge, and full-wave center-tap. The terms "half-wave" and "full-wave" refer to the AC-input waveform. In a half-wave circuit, only half of the 360-degree input voltage is applied to the load. In a full-wave circuit, the full 360 degrees is usable. Figure 1 shows their configurations and relationships.

The first consideration to be made in the transformer choice is the type of circuit configuration: full-wave center-tap or full-wave bridge. The half-wave rectifier is generally used only for low-current or high-frequency applications since it requires twice the filter capacitance to maintain the same ripple as a full-wave rectifier.

Both the center-tap and bridge configurations have their own merits. The center-tap circuit dissipates less power, requires less space, and is potentially more economical than the bridge because it uses only two (as opposed to four) rectifier diodes. Using only two diodes, it has a lower impedance than a bridge circuit. However, for the same DC output voltage, the diodes must have twice the PIV (peak inverse voltage) rating. And since diodes are inexpensive, there is less real economy in using center-tap transformers. Their selection often results more from finding available transformers with the proper secondary voltages for a particular application.

A 120-V AC RMS (root mean square) sine wave is applied to the primary winding of the transformer. A similar lower-voltage waveform is produced at the secondary windings. This AC output voltage is then applied to a full-wave bridge rectifier of the form described in figure 1.

Since we are dealing with actual components and not theoretical examples, it is important to note that different output voltages will be produced from bridge and center-tap circuits, even though they may start with the same secondary potential. If you observe a full-wave rectifier output on an oscilloscope, you will note a period of nonconduction at every zero crossing. Real diodes have an intrinsic voltage drop across them and dissipate power. For most low-current applications, this threshold voltage is about 0.6 V. At 5 A or more it is closer to 1.1 V.

Depending upon the configuration, one or two diode drops may be between the transformer and the filter capacitor. (Figure 2 shows the current flow through a bridge rectifier.) The voltage regulator requires a certain minimum DC input level to maintain a constant output voltage. Should the applied voltage drop below this point, output stability can be severely de-

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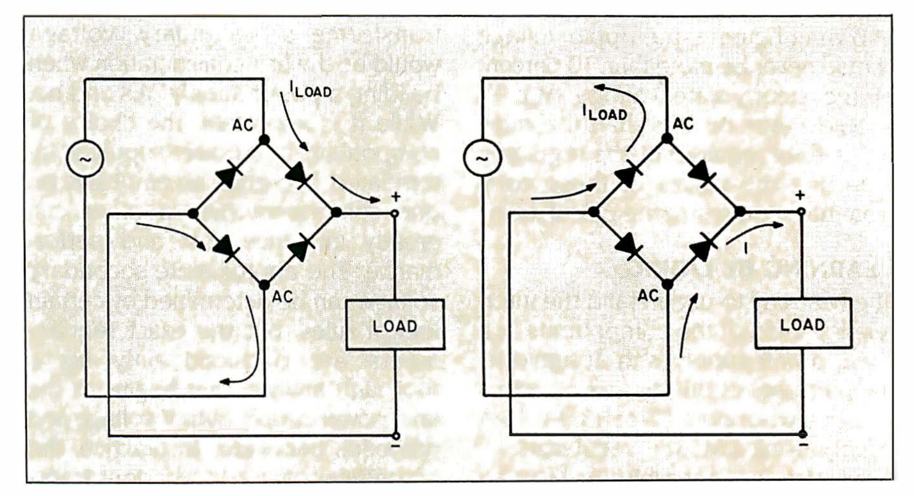


Figure 2: *The current flow through a full-wave bridge. Two diodes are conducting current at any one time. They present a voltage drop of 1 V each.*

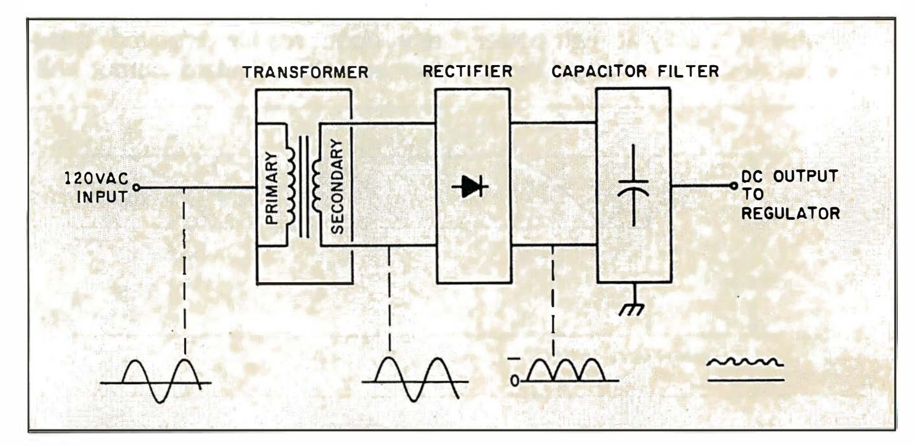


Figure 3: *The block diagram of a filtered power supply.*

graded. Where efficient low-dissipation designs are involved, these diode drops can be significant. In full-wave bridge designs, two diodes are in series at all times. The 2.2-V loss through the bridge is an important consideration that should be reflected in the calculations.

To smooth the rectifier output and help maintain a minimum input level to the voltage regulator, a filter capacitor is used (see figure 3). When the diodes are conducting, the capacitor stores enough energy to maintain the minimum voltage until the next charging cycle. With a 60-Hz transformer and a full-wave rectifier, the charging cycle has a frequency of 120 Hz. The capacitor must charge up in 8.3 milliseconds (ms) and maintain a sufficient level until the next charging cycle, 8.3 ms later.

The peak-to-peak magnitude of this periodic charge/discharge cycle is called the ripple voltage (V_{ripple}). The highest level of voltage including the ripple is called peak voltage (V_{peak}). Shown in figure 4, the ripple voltage should never be more than 10 percent of the steady-state voltage (V_c); V_c should never be less than the minimum input required by the regulator. Selecting the values of these components requires some calculation.

LEARNING BY DOING

The best way to understand the interrelationships of the components in a linear power supply is to design one. For purposes of this discussion, let us design a whopping 12- to 13.2-V 15-A supply using LM338K regulators.

This choice is not arbitrary. Most articles on linear power supplies present low-current circuits that are relatively idiot-proof. At such low currents, simple rule-of-thumb practice is acceptable. It is only at high power levels that design knowledge, layout principles, and proper component selection are mandatory. Somewhere in between the 5-watt (W) bench supply you build from an article for hobbyists and the 198-W supply we will discuss is a gray area where experimenters who rely on luck and rule of thumb will be out of one or both.

I am presenting such a big supply for another reason. For quite some time I've been receiving letters regarding uninterruptible power supplies. While I can't guarantee that I can design one that is more cost-effective than a commercial unit, I intend to investigate the options. To aid in this task, I need a high-current DC supply for the initial experiments. Rather than dragging in car batteries (a "12-V" car battery actually produces 13.2 V) and chargers, I thought I'd build a high-current supply that demonstrates something for this project and can be put to good use later.

198 WATTS!

You might think that specifying the transformer's secondary voltage would be the first consideration when building a power supply. Yes and no. While it is important, the choice of components in a power supply is interrelated. Too great an emphasis on one component over another can greatly influence cost and performance. The approximate secondary voltage can be determined by certain logical rules, but the exact requirements are deduced only by a thorough analysis that begins at the final power-supply output voltage and proceeds backward. In practice, the advantages gained in laborious transformer calculations are of benefit only to those designers capable of specifying custom-wound transformers. The majority of designers will have to rely upon readily acquired transformers with standard output voltages. For greatest efficiency, the standard voltage should be as close to the calculated value as possible.

Given an understanding of the basic filter components at this stage, we can proceed to the case at hand: a 13.2-V 15-A supply. The regulator, which I'll discuss later, uses the LM338K chip. These units are variable-voltage output devices, in contrast to fixed-voltage output devices such as the LM340T-5 (5 V) or 7812 (12 V). For them to properly operate over a temperature from 0 to 70°C, the input voltage to the LM338K must be 3 V greater than the output set point. (Fixed-voltage output regulators by contrast can suffice with a 2- to 2.5-V difference.) To be on the safe side, I always plan a minimum of 3.5 V. If this I/O (input/output) differential is less than 3 V, regulation becomes unstable. For a 13.2-V output, therefore, V_c has to be at least 16.7 V. For a 5-V output, V_c should be 8.5 V minimum. (Too much input voltage creates a different problem. Any $V_{out}-V_{in}$ difference greater than 3 V simply generates heat and should also be avoided.)

Whatever the magnitude of V_{peak} and V_{ripple}, V_c must not drop below 16.7 V or the regulator may not work. If this supply, which operates at 115-V AC input, is to still function at 105 V AC, we must make sure that V_c is 16.7 V at 105 V AC. The 8.5 percent voltage rise to 115 V AC, however, will make V_c 18.2 V (and 20.5 V at 130 V AC). Going much above these values, while still satisfying the input criteria, will increase power dissipation substantially.

Thus far, we have calculated or assumed the following at 25°C and 115-V AC input:

V_c = regulator input voltage at 115 V AC = 18.2 V
V_{ripple} = 10 percent of V_c maximum = 1.8 V
V_{peak} = V_c + V_{ripple} = 20 V
I_{out} = output current = 15 A
V_{rect} = voltage drop across diode bridge = 2.2 V (two diodes)

CHOOSING THE TRANSFORMER

We have determined the voltage drops across the various components and the minimum regulator input voltage. These values can be used to calculate the required RMS secondary output voltage as follows:

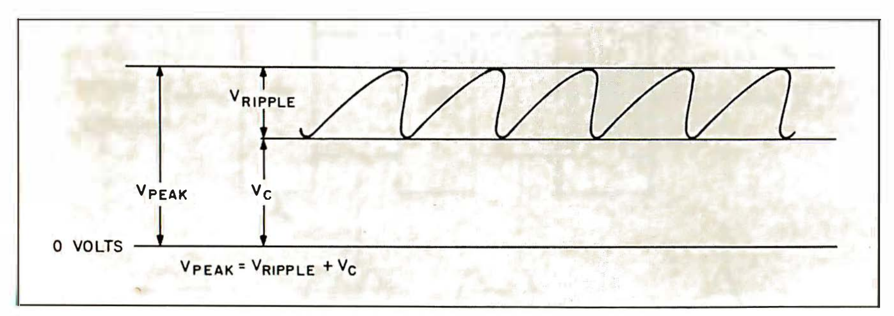


Figure 4: *The components of peak voltage, V_{peak}, are the steady-state voltage, V_C, and the ripple voltage, V_{ripple}.*

$$V_{sec,rms} = \frac{V_c + V_{ripple} + V_{rect}}{\sqrt{2}}$$

$$= \frac{18.2 + 1.8 + 2.2}{1.414}$$

$$= 15.70 \text{ V AC}$$

In practice, 15-A 15.70-V transformers aren't available off the shelf, but many 15- and 18-V units are available. While 16 V is the proper transformer secondary-winding selection, 15- and 18-V 10-A transformers will work fine if you can live with 10 A rather than 15 A. (One of these is part number F-62U from Triad-Utrad, 1124 East Franklin St., POB 1147, Huntington, IN 46750.) The 15-V unit will not give complete operation to 105 V AC, however, and the 18-V transformer will increase power dissipation in the regulator by 12.5 percent. (I don't recommend using 25.2-V center-tap transformers.)

I don't like presenting an optimized design and then apologizing for not taking my own advice. The calculations might seem a bit rigged when you find that I just happened to use a 16-V 15-A transformer to complete this project. I have to confess that I had it custom wound to meet the application. While I don't expect the average experimenter to resort to such expensive tactics, when I build a piece of test equipment, I want reliable and consistent operation. The final transformer secondary winding is 16 V AC at 15 A, and the secondary resistance is 0.04 ohm. (A 2-A 18-V center-tap transformer such as the Radio Shack 273-1515A by contrast is about 0.6 ohm.) With the additional wiring and connections between the transformer and the bridge, the source resistance is about 0.1 ohm.

Using a 16-V transformer, the true, as opposed to calculated, voltage levels are

V_{sec} = 16 V AC
V_{rect} = 2.2 V
$V_{peak} = (V_{sec} \times 1.414) - V_{rect} = 20.4$ V
V_c = 18.6 V
V_{ripple} = 1.8 V
R_s = transformer secondary resistance and resistance of connecting wires = 0.1 ohm

Sizing the Filter Capacitor

When the supply is turned on, a 120-Hz rectifier output is applied to the capacitor. The capacitor is large enough so that it can supply the full load current with only a negligible drop. If the capacitor is very near peak when the next charging cycle occurs, as would be the case with light loads and large capacitors, the diodes conduct for a very short time. The exact time during which the capacitor supplies current is fixed by the permissible peak-to-peak ripple voltage. This time:

$$T_{conduction} = (\theta/180)\ (8.33) \text{ ms}$$

where $\theta = [90 + \arcsin(V_c/V_{peak})]$ degrees.

For ripple voltages equivalent to 10 percent of V_{peak}, the filter-capacitor conduction time is 7.14 ms rather than 8.33 ms. For simplicity, however, it is often assumed that the capacitor must carry current for the full half cycle and 8.33 ms is used in the calculations. The capacitor value is chosen as follows:

$$C = (T_c/V_{ripple})\ I$$

where C = capacitance in farads (F) = ?, I = continuous output current = 15 A, T_c = charging time of capacitor = 8.33 ms, and V_{ripple} = allowable ripple voltage = 1.8 V. Plugging in the values:

$$C = \frac{(15)\ (0.00833)}{(1.8)}$$

$$= 0.069417 \text{ F}$$

or

$$= 69{,}000 \text{ microfarads } (\mu F)$$

In the nearest commercial value, C = 75,000 μF at 25 V. Generally available commercial electrolytic capacitors have a tolerance of +50 percent and −10 percent. I chose to use a General Electric 86F543 75,000-μF 25-V (V_{peak} is 20 V) unit, but any capacitor of similar size will work. The ripple-current rating on capacitors of this size is also adequate.

Choosing the Bridge Rectifier

The four considerations when choosing a bridge rectifier are surge current, continuous current, PIV rating, and power dissipation. These parameters are generally ignored in rule-of-thumb designs because the 3- and 10-A diode bridges (which are generally available, coincidentally) have ratings

When I build a piece of test equipment, I want reliable and consistent operation.

that protect against bad designs. With 15-A power supplies, however, we should take nothing for granted. These specifications are not inconsequential and must be considered.

When a power supply is first turned on, the filter is totally discharged and for an instant appears as a dead short to the diode bridge. In this condition, the only thing that limits the current flowing through the bridge is the resistance in the secondary windings and the connecting wires. This sudden inrush is called surge current and is computed as follows:

$$I_{surge} = \frac{V_{peak}}{R_s}$$

$$= 20.4/0.1$$

$$= 204 \text{ A}$$

The time constant of the capacitor is

$$\tau = (Rs)\ (C)$$

$$= (0.1)\ (0.075000)$$

$$= 7.5 \text{ ms}$$

Generally speaking, power surges will not damage the bridge if the surge is less than its surge-current rating and if the time constant, τ, is less than 8.33 ms, which it is. A readily available bridge rectifier that fits the bill is the Motorola MDA990-2, which is rated at 30 A continuous and 300 A surge. Its PIV rating is 100 V, which is significantly in excess of our 22.6-V secondary peak.

One final consideration on the bridge is power dissipation. Since diodes exhibit voltage drops when current flows through them, they dissipate power just as the regulators do. The rule of thumb says that if I_{out} is 15 A and V_{rect} is 2.2 V, power dissipation (PD) is 33 W. Such a high value would suggest the need for a heatsink.

A possibility exists, however, that

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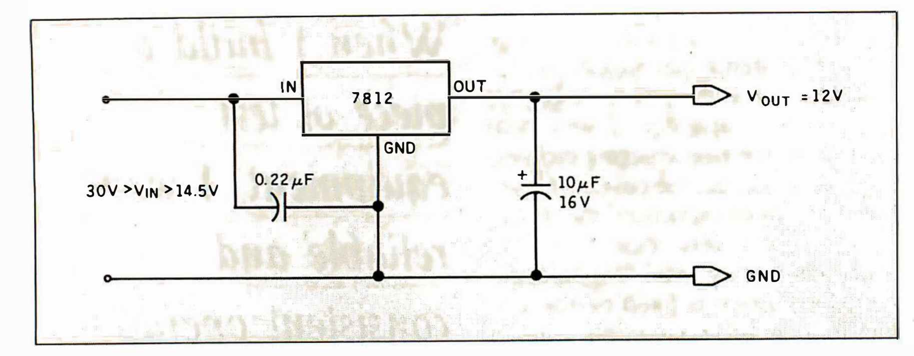


Figure 5: A *typical +12-V fixed-voltage output regulator.*

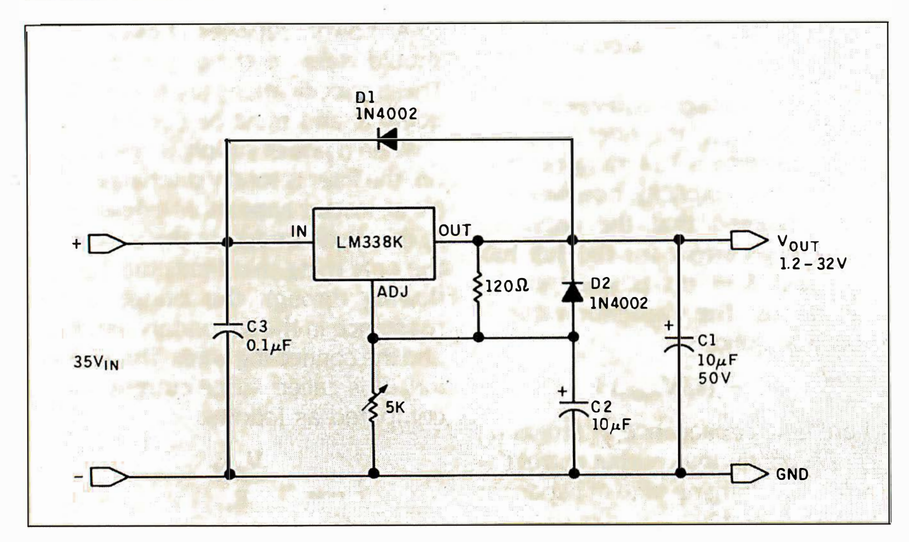


Figure 6: A *typical variable-voltage three-terminal regulator.*

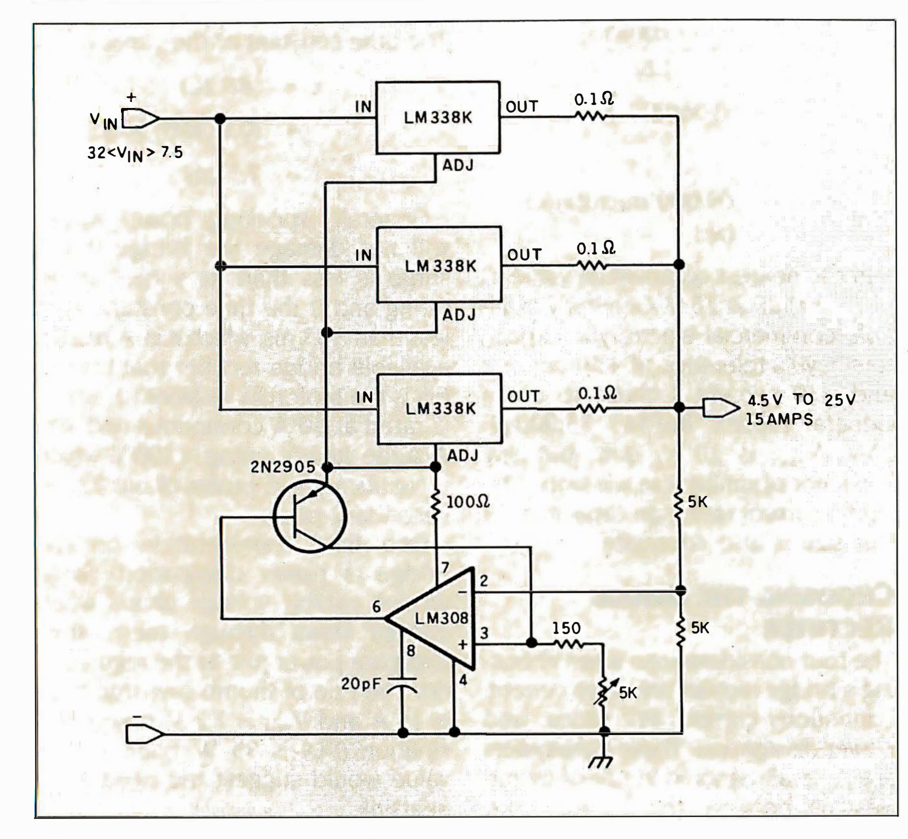


Figure 7: A *15-A multiple regulator.*

the true (as opposed to the rule-of-thumb) PD could be significantly different and may or may not need extraordinary measures for heat removal. At the very least, you might like to know how to calculate real dissipation.

First, the only time the diode in the bridge conducts for a full cycle is immediately after turn-on. After that, it conducts only during that period when the input voltage is greater than V_c. In our supply, V_c is 18.6 V and V_{peak} is 20.4 V.

You'll remember that I previously said that the capacitor supplied power for 7.14 ms of every 8.33-ms charging cycle. The diode, therefore, conducts for the remaining 1.19 ms. (The time depends on the amplitude of the ripple.) During this time, the transformer and diodes must charge the capacitor from 18.6 to 20.4 V while they also supply power to the load. The required current is

$$I_p = \frac{(C)\ (V_{ripple})}{T_c}$$

$$= \frac{(0.075\ F)\ (1.8\ V)}{(1.19\ ms)}$$

$$= 113.4\ A$$

To this you add the output current of 15 A: I_p = 128.4 A peak. This translates to a peak power dissipation of

$$PD = I_p \times V_{rect}$$

$$= 128.4 \times 2.2$$

$$= 282.5\ W\ peak!$$

However, this occurs for each pair of diodes for only 1.19 out of 16.6 ms, and the average power becomes

$$= (282.5) \times (1.19/16.6)$$

$$PD = 20.25\ W\ average$$

Twenty watts isn't much. Simply mounting the bridge to the metal power-supply enclosure should provide enough cooling. To know for sure, however, look up the bridge's rated junction temperature, keep the PD value in mind, and calculate the cooling requirements when we get to heatsinking.

VOLTAGE REGULATORS

Once the filter section is configured, our next consideration is the voltage regulator. All linear regulators perform the same task: convert a given DC input voltage into a specific,

stable, DC output voltage and maintain it over wide variations of input voltage and output load.

Entire books have been written on regulation circuits, and I think the subject material is adequate. The best sources are, in fact, the data manuals from the regulator-chip manufacturers. These manuals specify the I/O voltages and other specifications important to the power-supply designer. (Rather than go into the history and successive milestones in regulator evolution, I'm going to presume that you know a lot about this and want me to quickly get back to building a real supply.)

Three-terminal regulators come as fixed- or variable-voltage output devices (fixed-voltage output regulators can be configured to provide variable-voltage outputs). A typical +12-V fixed-voltage output regulator is shown in figure 5. The regulator has three terminals: in, out, and ground reference. In a 7812 regulator, $V_{out} - V_{in}$ should be 2.5 V; therefore, V_c should be 14.5 V for proper operation. The maximum input, disregarding power dissipation as a limiting factor, is 30 V.

If you want a 13.2-V supply, you would substitute a variable-voltage three-terminal regulator such as the LM338K shown in figure 6. Here, the three terminals become in, out, and voltage adjust. A potentiometer in the adjust line sets a reference level to the chip that determines its output voltage. This circuit also contains diodes to protect the regulator.

While manufacturers would like you to think otherwise, three-terminal regulators are not indestructible and can fail. One source of failure is the discharge of external capacitors through the regulator. For example, if the regulator output is shorted, C2 will discharge through the voltage-adjust pin. A diode, D2, diverts the current around the regulator protecting it. If the input is shorted, C1 can discharge through the output of the regulator, possibly destroying it. Diode D1 shunts the current around the regulator, protecting it. While such protection is merely insurance on hefty devices such as the LM338K, it is a necessity on lower-current regulators.

The LM338K can be adjusted for outputs from 1.2 to 32 V at 5 A, and devices can be paralleled to provide increased output current. Figure 7 outlines a circuit composed of three LM338Ks configured as a 15-A regulator that will satisfy the regulation requirements of the supply we are building. With a V_c input of 18.6 V at 115-V AC input, the supply is adjustable from about 4.5 to 15.6 V. Figure 8 is the final schematic of the unit.

Three-terminal regulators have been known to fail.

Layout Is Important

Three-terminal regulators employ wideband transistors to optimize response. Unfortunately, stray capacitance and line inductance caused by poor layout can introduce oscillations and unstable operation into these circuits. Keeping lead lengths short, as shown in photo 1, and adding external bypass capacitors will limit the problems caused by the regulator. Builder-introduced problems are another matter entirely.

Figure 9 illustrates a typical three-terminal-regulator supply layout, including the areas that can cause problems. All wires and connections within a power supply have resistance. In the case of high-current supplies such as ours, small resistances can introduce major errors. For example, a 0.1-ohm resistance at 15 A drops 1.5 V. Heavy wire should be used, and it is impor-

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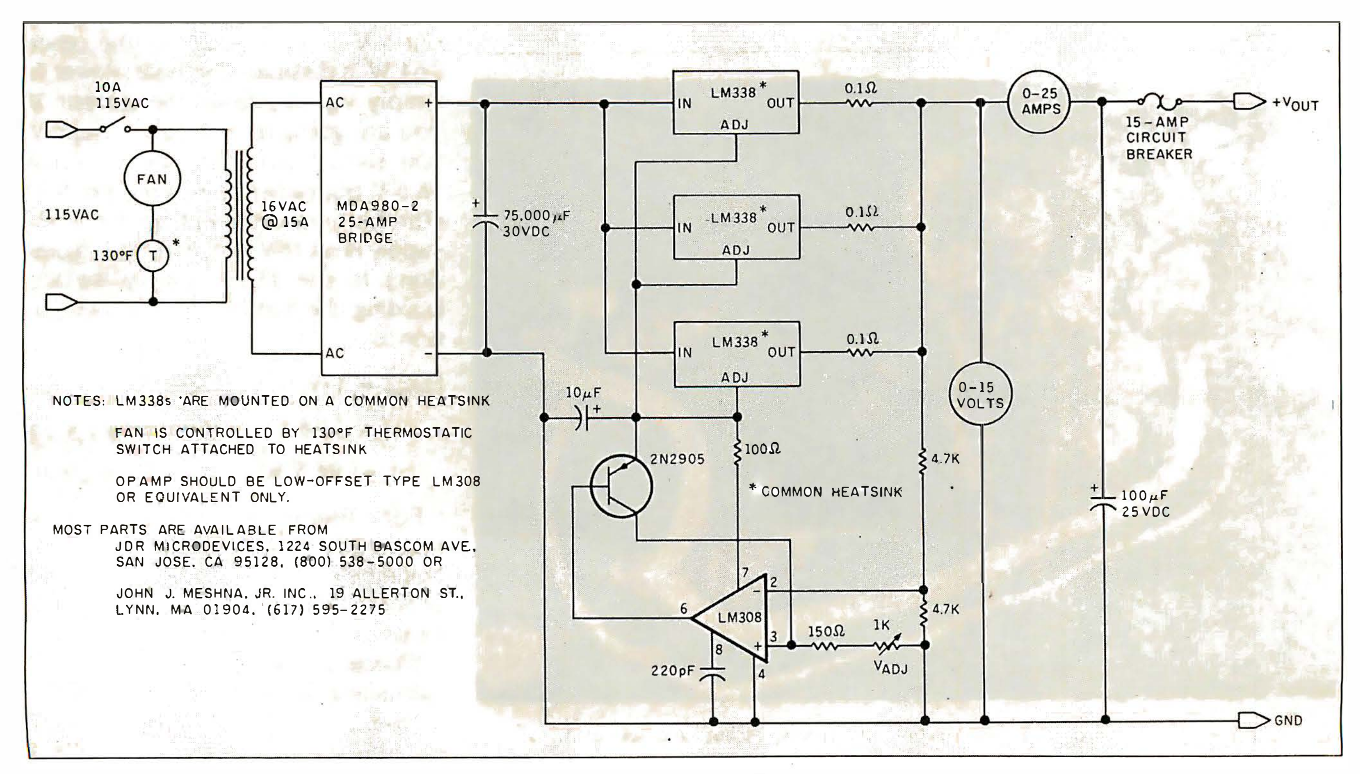


Figure 8: A 12- to 13.2-V 15-A *power supply that uses readily available components.*

tant to separate the charging-current and the output-current paths.

As demonstrated in figure 9, improper placement of the input capacitor can induce unwanted ripple on the output voltage. This occurs when the charging current to the filter capacitor influences the common ground or voltage-adjustment line of the regulator. As previously mentioned, the peak currents in the filter circuit are in excess of 100 A. The voltage drop across R2′ will cause the output to fluctuate as if the voltage trim were being adjusted.

The output-current loop is also susceptible to layout. In a three-terminal fixed-voltage output regulator, the output voltage is referenced between the output pin and the common line of the chip. Because the load current flows through R2′, R3′, and R4′ before reaching R_{load}, there may not be the correct voltage across the load due to accumulated voltage drops in the wiring. Also, while points B and C are both ground, they are at different voltages depending upon the resistance of and the current flowing through R3′. Similarly, resistance R4′ in the output lines continually reduces the output voltage as the current increases. This serves to negate the purpose of the regulator.

Figure 10 is a diagram of the proper layout. In the layout, all high-current paths should use heavy wire to minimize resistance, and the input-filter and output-load circuits are effectively separated. Most important, the wires from the transformer go directly to the bridge and then to the filter capacitor. Power to the rest of the circuit should come directly from the terminals of the capacitor and not from any point between the bridge and the capacitor. The result is two sets of wires (input from the bridge and output to the regulator) connected to the capacitor—but it is absolutely necessary. Mixing current paths is the most common problem in experimenter-built supplies.

The last layout consideration is the concept of a single-point ground. One point in the power supply must be designated as the ground, and the ground connections of the other circuit sections are connected to it. In practical terms, this is often just a metal strip or busbar called a ground bus. There should be virtually no measurable voltage between any two points on this bus. Don't be afraid to use thick wire!

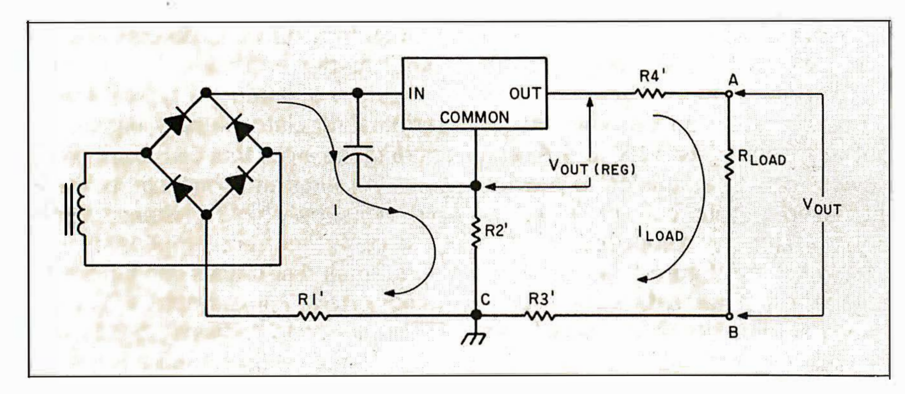


Figure 9: *Sources of layout-induced errors in a typical three-terminal-regulator power supply.*

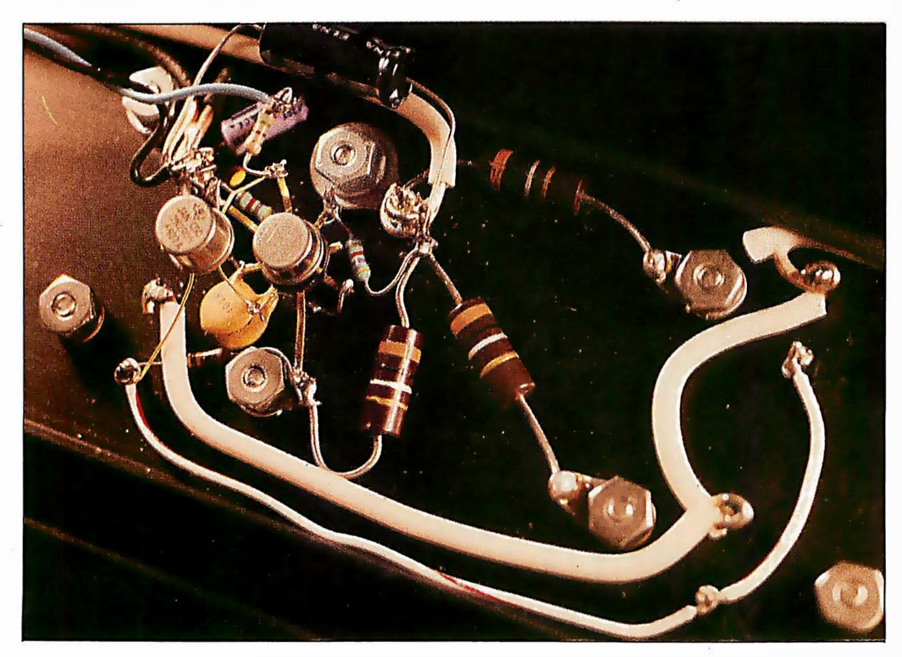


Photo 1: *Short leads in the regulator sections limit noise pickup and add to overall stability. In my prototype, I connected the op amp and other discrete components directly to the regulators on the bottom side of the heatsink.*

Heatsinking

The final consideration is heatsinking. Generally speaking, linear power supplies, while easy to build, are grossly inefficient. A 45 percent-efficient design is good (the usual range is 40 to 55 percent). Before you start thinking of this as both a 5- and 15-V 15-A supply, remember the old saying, "what goes in, comes out." With a 16-V_{rms} 15-A input, we are putting in 16 × 1.414 × 15 = 339 W and taking out 5 V × 15 A = 75 W. The other 264 W is dissipated in heat. Power is simply $V_{out} - V_{in}$ times the current. If you are going to want a 5-V supply, you should not start with a V_c of 18.6 V but rather something like 9 V. (The best transformer/filter for a 5-V supply is an 18-V center-tap configuration.) In the 13.2-V supply we are building, the maximum power dissipation is

$$PD_{max} = ((V_c + V_{ripple}/2) - V_{out}) \times (I_{out})$$
$$= ((18.6 + 1.8/2) - 13.2) \times 15$$
$$= 94.5\ W$$

For linear supplies of this magnitude, 95 W is relatively cool. Nonetheless, it must be dissipated properly through a device called a heatsink, as shown in photo 2.

Basically, the entire process of calculating factors such as dissipation, temperature rise, and junction temperatures is to determine a quantitative value of absorbable power for a given set of physical conditions. For

a predetermined rise in heatsink temperature, you will be able to calculate the maximum power dissipation of the circuit to maintain that limit or, vice versa, to calculate the junction and heatsink temperatures given the input power.

Heatsink ratings and heat transfer through component mountings are stated in terms of thermal resistance: °C/W. For a particular application, it is necessary to determine the thermal resistance that a cooler must have to maintain a junction temperature that sustains adequate semiconductor performance. The basic relationship is

$$PD = \frac{\Delta T}{\Sigma R_\theta}$$

where PD = power dissipated in the semiconductor, ΔT = difference in temperature between ambient and the heatsink, and ΣR_θ = the sum of the thermal resistances of the heat flow path across which ΔT exists. In elaboration:

$$PD = \frac{T_j - T_a}{R_{jc} + R_{cs} + R_{sa}}$$

where T_j = the maximum junction temperature as stated by the semiconductor manufacturer (°C), T_a = ambient temperature (°C), R_{jc} = thermal resistance from junction to case of semiconductor (°C/W), R_{cs} = thermal resistance through the interface between the semiconductor case and the heatsink (°C/W), and R_{sa} = thermal resistance from heatsink to ambient air (°C/W).

The best way to understand this is to look at an example. First, we have a 7805T in a TO-220 case that is dissipating 5 W, and we select the proper heatsink. Given:

PD = 5 W
R_{jc} = 4°C/W (from the manufacturer)
T_j = 125°C maximum for TO-220 package
T_a = 50°C ambient
R_{cs} = 1°C/W insulator with heatsink grease

We use the equation for PD to solve for R_{sa}:

$$R_{sa} = \frac{125 - 50}{5} - (4 + 1)$$

$$R_{sa} = 10°C/W$$

Thermalloy part number 6299B has a 50° rise in temperature for a 12-W input. Therefore:

$$R_{sa} = 50/12 = 4.16°C/W$$

The 6299B is more than adequate for the task and will, in fact, heat up only 4.16 × 5 = 20.8°C over ambient in this example.

Getting back to the supply we are building, the minimum power dissipation is at maximum output voltage and vice versa. If the supply will be used in the range of 12 to 14 V, the heatsinking must accommodate the worst-case conditions. When the output is set for 12 V, the power dissipated in the regulator section will be 112.5 W (at 15 A). Each of the three regulators will be dissipating 112.5/3 or 37.5 W. The minimum R_{sa} is as follows. Given:

PD = 37.5 W
R_{jc} = 1.0°C/W
T_j = 125°C
T_a = 40°C
R_{cs} = 0.28°C/W (anodized washer and heatsink grease)

The R_{sa} minimum is thus

$$R_{sa} = \frac{125 - 40}{37.5} - (1 + 0.28)$$

$$= 0.99°C/W$$

A 3-inch piece of Thermalloy part number 6560 has a 0.70°C/W R_{sa}

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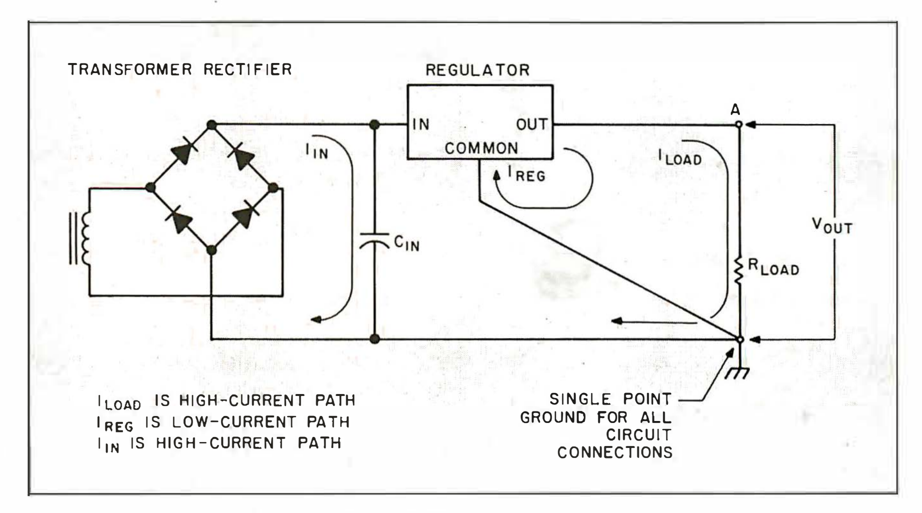


Figure 10: *The proper power-supply layout.*

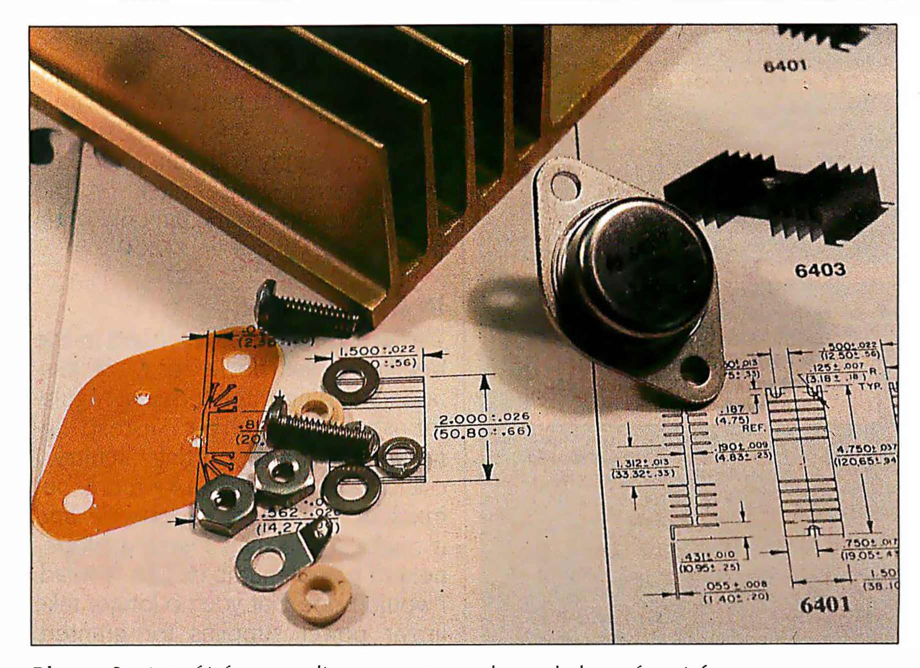


Photo 2: *Any high-current linear power supply needs large heatsinks to carry away the heat dissipated in the regulators. When more than one regulator is to be mounted on the same heatsink, special insulated mounting kits must be used.*

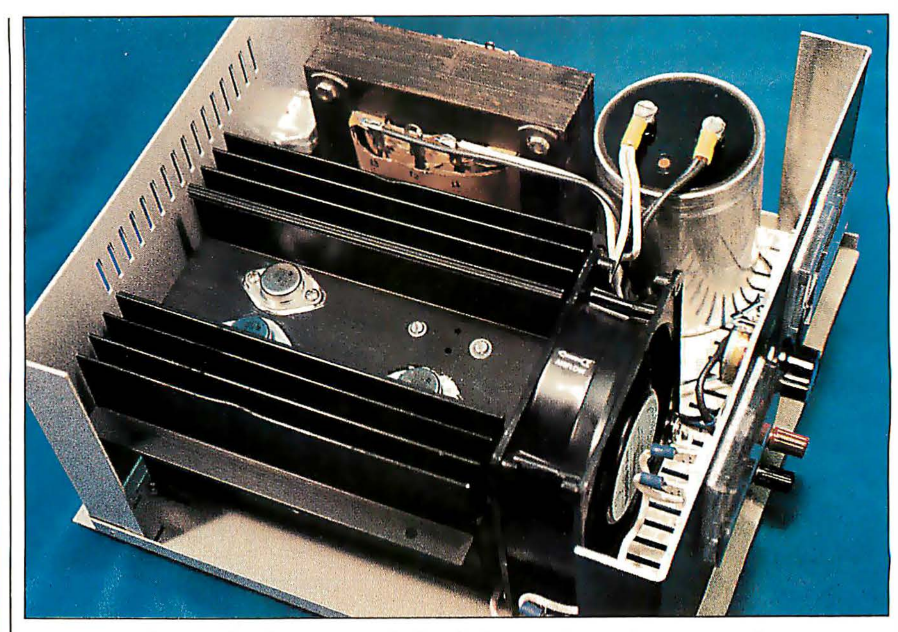


Photo 3: *The completed power supply has little extra internal space. You'll notice that the filter capacitor has two sets of connecting wires to conform to the layout guidelines I've described. While the heatsink is sized properly for ambient air installations, I have added a fan to compensate for the insulating effect of the enclosure. To limit noise, the fan is controlled by a 130°F thermostat attached to the heatsink. The thermostat turns on the fan only when necessary.*

value. It would operate satisfactorily for an individual LM338K. A 7-inch piece of the same material would have an effective R_{sa} of 0.42°C/W.

To accommodate the full 125 W, forced-air cooling is recommended. From the data I have at hand, it appears that R_{sa} is reduced approximately by half with 600-cubic-feet-per-minute forced convection. With a fan on the heatsink, 112.5 W should be adequately dissipated while maintaining a low ambient temperature within the supply case. Photo 3 shows the complete supply with fan. I added a 130°F thermostatic switch on the heatsink to turn on the fan only when needed.

In Conclusion

The product failure described in the beginning was not a result of misunderstanding three-terminal-regulator specifications but instead ignorance of the supporting circuitry. I could have discussed a lot more, but much of it relates to experience, and it might sound as if I were a proponent of rule-of-thumb design. Instead, I would hope that you no longer take linear power supplies for granted. Even in today's VLSI (very-large-scale integration) world we continue to depend on tried-and-true, even if somewhat ancient, designs. Linear power supplies have a definite place in our world of electronics.

I don't expect venture capitalists to get excited about power-supply design, but the next time the words "meltdown" and "incendiary" are mentioned, I know a few who will be listening more closely.

Circuit Cellar Feedback

This month's feedback begins on page 413.

Next Month

Steve will be building a low-cost serial EPROM programmer. ■

This article is dedicated to Kram Nurtam and the E product. May that great heatsink in the sky cool any thoughts he might have of designing another linear power supply.

Editor's Note: Steve often refers to previous Circuit Cellar articles. Most of these past articles are available in reprint books from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.

Ciarcia's Circuit Cellar, Volume I covers articles that appeared in BYTE from September 1977 through November 1978. *Volume* II covers December 1978 through June 1980. *Volume* III covers July 1980 through December 1981. *Volume* IV covers January 1982 through June 1983.

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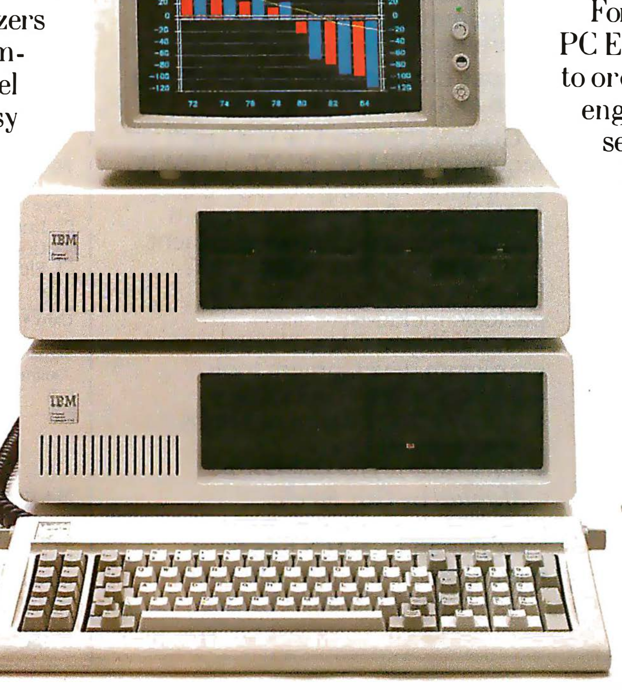
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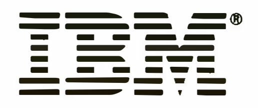
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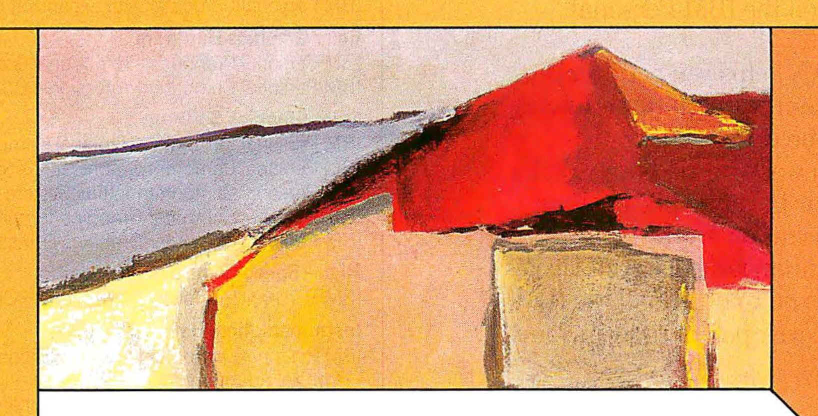
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Inquiry 150

BY BILL BENZON

THE VISUAL MIND AND THE MACINTOSH

MacPaint provides a tool for thinking

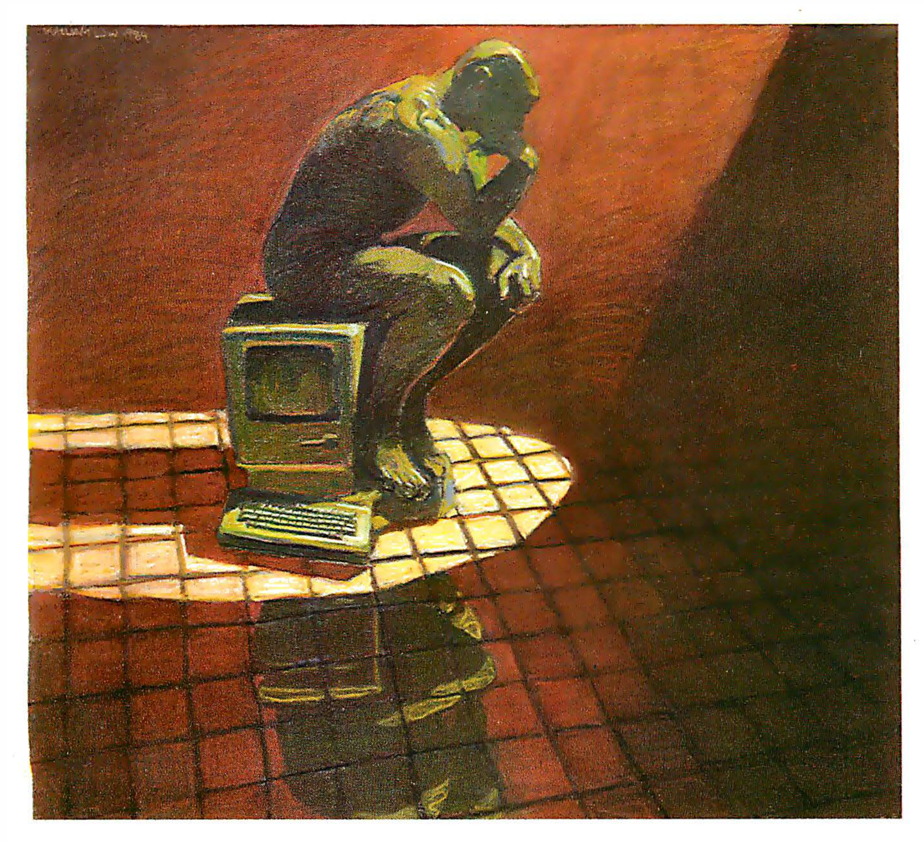
Late in 1974 Ed Roberts and Eddie Curry, principals in Micro Instrumentation and Telemetry (MITS), designed and began marketing a microcomputer kit. That kit was featured in the January 1975 issue of *Popular Electronics* and the rest, as they say, is history.

In my opinion, the Apple Macintosh is the most significant microcomputer since that original MITS kit, but its importance hasn't been adequately explained. The Mac is user friendly, but even more important is what lies beyond that user-friendly interface—MacPaint.

MacPaint provides visual power. It is fun to use—you can zap the mouse around, draw a zillion rectangles in a minute, put four reflecting planes in the drawing space, and create amazing symmetrical designs with mere flicks of the wrist. Why is this important? As figure 1 indicates, one hemisphere of the brain is more or less verbal while the other is more or less visual (see reference 1). The Macintosh is a tool for the visual brain.

The Mac allows us to do fascinating things with typography. We can crank out bar charts, pie charts, and line graphs. We can do maps 50 ways from Sunday and play with line drawings to our hearts' content. But we can also think visually and relate visuals to verbals with a facility not readily available before.

The Macintosh is a tool for thinking. To understand the implications of this statement, we need to know something about the thinking process. In this article I hope to discuss thinking in a way that will make the significance of the Macintosh more obvious. Consequently, most of this article is specifically about thinking and only indirectly about the Macintosh.



ILLUSTRATED BY WILLIAM LOW



VISUAL THINKING

The anecdotal literature on creativity is full of stories about great thinkers who work in images. Consider the

(continued)

Bill Benzon (Language, Literature, and Communication, Rensselaer Polytechnic Institute, Troy, NY 12181) holds a Ph.D. in English from State University of New York at Buffalo. He has done research on cognitive science and literary theory and has held a fellowship with NASA to work on a strategic computing plan. Bill also does consulting and freelance writing.

following passage from a letter by Albert Einstein (see reference 2):

> The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be "voluntarily" reproduced and combined. . . . The above mentioned elements are, in my case, of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary stage, when the mentioned associative play is sufficiently established and can be reproduced at will.

Thus it seems Einstein's primary mode of thought was not words or even mathematical symbols. He thought in images and then translated those image-born insights into verbal or mathematical form.

Or consider Watson and Crick and the double helix. Why did they actually build a three-dimensional model of the helix while they were working up the basic ideas (see reference 3)? Because however important visual thinking is, it is difficult to hold an image in your mind and work with it—especially if it is a three-dimensional shape. But if you can externalize the image and make a model as Watson and Crick did, then working with it becomes easier.

Writing and drawing provide external support for thought. Writing supports the work of the verbal brain. Learning the mechanics of writing—how to form the letters or use a keyboard—is relatively easy, and once that is out of the way, you can go on to the tough stuff—writing things that make sense and may be beautiful as well. However, images, whether two- or three-dimensional, are different. Becoming proficient in the mere mechanics of freehand drawing—for example, drawing a picture of a horse

By making it easy for you to create images and work with them, the Macintosh can help you to think.

that looks more like a horse than like a camel or a rabbit—is difficult. Technical drawing is easier but it is still more difficult than writing.

By making it easy for us to create images and work with them, the Macintosh can help us to think. Perhaps our society will create a pool of images for thinking comparable to our pool of proverbs and stories. We have a large number of proverbs and countless stories, such as Aesop's fables, which we learn and use for thinking. We apply these proverbs and fables to situations that arise and from that we get some idea of how to act. Why not have a pool of images that we can use in the same way? What I have in mind can best be illustrated by an example. It is called the gestalt switch.

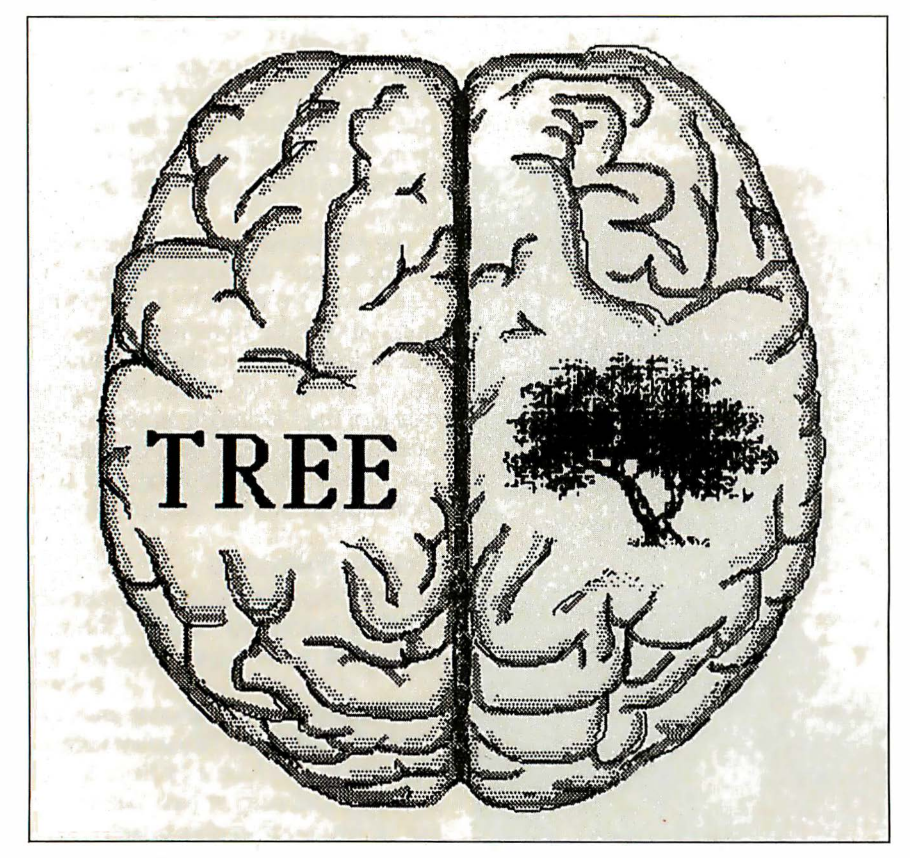


Figure 1: *The left or verbal side and the right or visual side of the human brain. The tree is a McPic image. (McPic is a product of Magnum Software, 21115 Devonshire St., Ste. 337, Chatsworth, CA 91311, (818) 700-0510).*

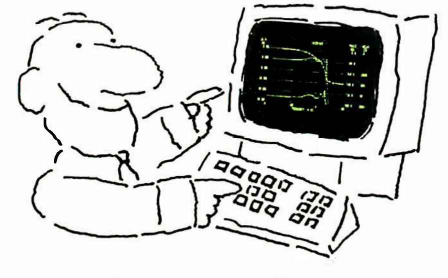
THE GESTALT SWITCH

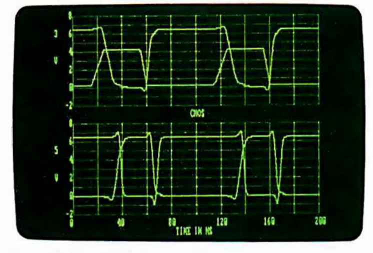
In 1962 Thomas Kuhn published a book on the nature of scientific revolutions that set off bombshells in the academic world (see reference 4). For example, Kuhn was interested in how Copernicus's *heliocentric* model of the solar system replaced Ptolemy's *geocentric* model, how Newtonian mechanics replaced Aristotelian mechanics, and how Newtonian mechanics was then replaced by relativistic and quantum mechanics. You would think that as more observations came in and older theories didn't hold up, they would be replaced by newer ones. However, in the case of Copernicus's heliocentric model, the old theory fit the available data better than the new one.

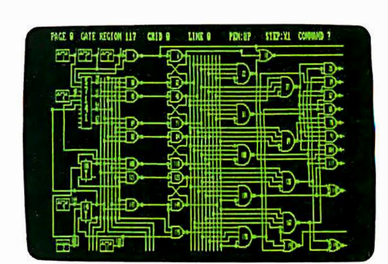
Kuhn's conclusion is a bit compli-

(continued)

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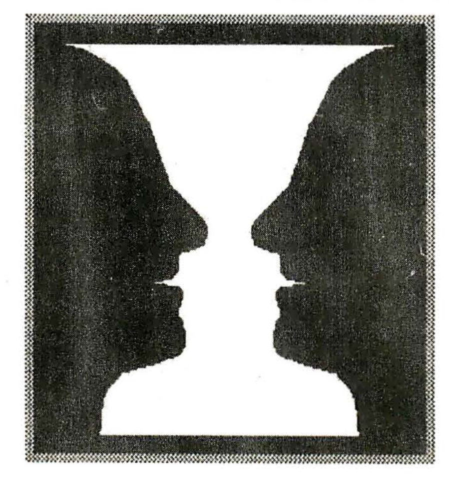
cated but the basic point can be made rather easily with an image. The upper image in figure 2 shows one of those ambiguous pictures from freshman psychology textbooks. Is it a picture of two men facing each other or is it a vase? You can see it either way, and you can switch back and forth between the two interpretations easily.

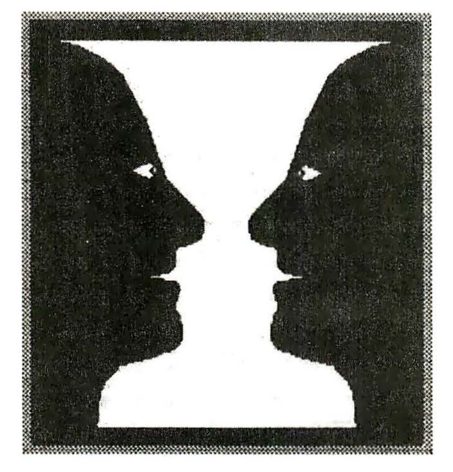
Kuhn concluded that scientific data, observations, and hard empirical facts are like this drawing. Before they have meaning, they must be interpreted by a theory; different theories describe them in different ways and lead to different expectations about future observations. In other words, if you see the ambiguous image as two men, you will talk about noses, lips, and chins and expect to find shoulders and arms beneath them. But if you see it as a vase, you will refer to the base, the rim, and the constriction in the middle and expect to see it on a tabletop or a shelf.

Now, imagine that you give two people in two different rooms copies of this ambiguous figure. You tell one that it's a picture of two men and the other that it's a vase. If you give these people a phone and let them talk to one another, how long will it take them to discover they are talking about the same drawing? After all, one is talking about noses and chins while the other is discussing rims and bases. That, says Kuhn, is the problem between scientists with different theories about the same data: they live in different intellectual worlds.

Of course these two people would communicate better if they described the image in terms of, for example, pixels. Why can't scientists do the same? Science isn't as simple as this visual analogy might lead you to believe. Like all analogies, this one is limited; it won't take you all the way, but it gives you a good start.

The original ambiguous figure was created by a school of psychologists interested in perception. They believed that we see images whole, not just as the sum of individual parts, and so they talked of *gestalt* (a German word meaning "whole") psychology. The phenomenon of switching back and forth from one interpretation of a visual image to another has come to be known as the *gestalt* switch and the ambiguous figures that evoke this switch are useful things to think with. They are the visual equivalent of a proverb or a fable.





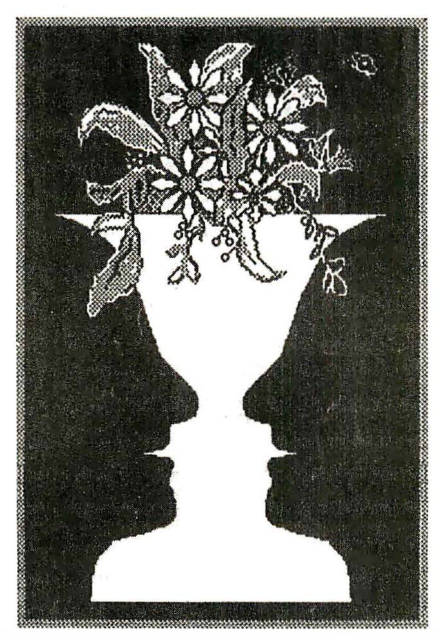


Figure 2: *The gestalt switch. The drawing at the top is ambiguous; you can see it as either two men facing one another or as a vase. You can emphasize either one of these interpretations by changing the drawing as shown in the middle and at the bottom.*

We all have our own visual proverbs but we don't think of them as such. Our society doesn't gather them together and pass them on like it does verbal proverbs and fables, partly because images are more difficult to reproduce and distribute than words. Talking is easy, but drawing requires that you have proper materials and skills, which aren't always at hand. Words are easy and inexpensive to print, but images are more difficult and therefore more costly.

Images are much easier to create and distribute through the Macintosh's graphics facilities. You can exchange printouts or disks or send the images through computer networks. As this power becomes available to more people, you may well begin to see people creating, exchanging, and collecting visual proverbs.

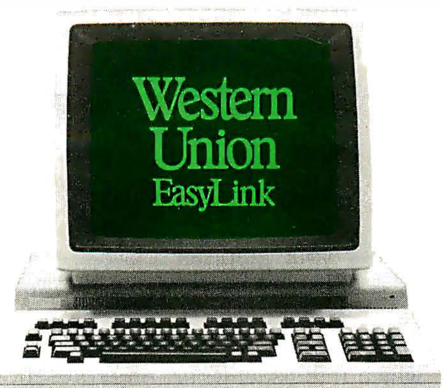
Webs of Ideas

The further development of a visual society is particularly important as we stand on the threshold of the information age because the intellectual world of information, of computing, is an intensely visual one. From circuit design to chip layout, from flowcharts to data structures, computing is visual. If good diagrams were easier to draw, then more would be drawn, and more people would grasp what computing is about. And the more people understand computing, the more they will use it.

Consider the area of knowledge representation (a subfield of artificial intelligence). Many researchers use a notation called the *directed* graph (see figure 3). The ellipses are called nodes and the connections between them are called arcs. Nodes stand for concepts while arcs indicate the relationships between them. In this example VAR means "variety of" while CMP means "component of." Thus, maple

(continued)







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is a variety of tree while trunk is a component of it.

The graph is not, however, the only notation you can use. If you want to prove theorems about the abstract properties of knowledge structure then you'll choose a propositional notation (see listing 1). If you want to program the propositional notation into a computer, then you'll have to think in terms of a complex list with addresses and pointers. But if you want to think about how ideas fit together and teach this material to others, then the graph notation is the most useful one. Further, if you are dealing with structures that are three or four times more complex than the one I've shown and if you typically work with structures 10, 100, or 1000 times more complex, then the propositional form is unreadable. You can't do any useful work with it. However, the visual representation is still useful; even if your graph covers half your desk and starts climbing up the wall you can work with it.

The graph is a notation system in which the visual form can represent the structure of the information very clearly. Well-drawn graphs show important and interesting information structures at a glance. The more you can encompass in a single mental operation, in this case, a glance, the better you can work with your material (see reference 5). A graph extends the range of a single mental operation far beyond that available with a listing. A single glance at a list of commands tells you nothing; you have to read each one, line by line, and painstakingly assemble them in your mind.

Conceptual graphs were not, however, invented yesterday. Many of us learned English grammar through sentence diagramming, which is a technique for giving visual form to grammatical structure. One important contemporary form of this is called dependency theory, which, in one version or another, is important in computer models of language (see reference 6). One dependency theorist, David G. Hays, says that he was inspired, in part, by the sentence diagramming he did in his youth.

If you think about how ideas fit, the graph is more useful than propositional notation or a complex list.

Beyond this consider the work of Tony Buzan and Gabriele Rico, who have been developing techniques for helping people to think and to write better (see references 7 and 8). Both teach people to draw networks—Buzan calls them mind maps, Rico calls them clusters. Their networks are much freer than the ones knowledge representation theorists use, but their purposes are quite different. The theorists are developing formal models of how people think and they find the network notation useful for this. Buzan and Rico are interested in helping people think and they find that drawing networks is a much better way of working out preliminary ideas than trying to put thoughts into an outline. I suppose that the work of knowledge representation theorists could be used to justify these techniques for helping people to think. For example, if we in fact think with networks, then doodling network diagrams seems to take advantage of that. But that is a long and complex argument, one irrelevant to my main point—that diagrams help us think.

Listing 1: *The propositional representation of the relationships shown in the directed graph in figure 3.*

```
VAR (maple,tree)
VAR (oak,tree)
VAR (pin oak,oak)

CMP (leaves,tree)
CMP (trunk,tree)
```

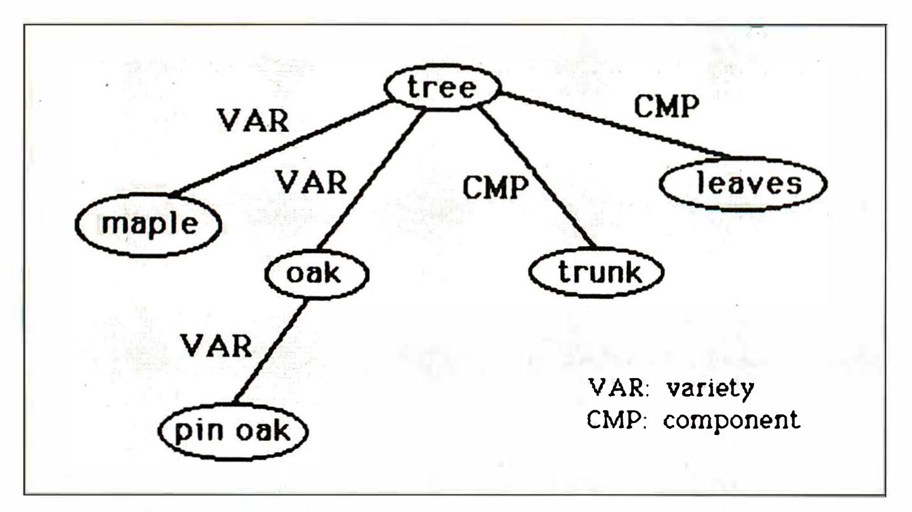


Figure 3: A *notation used in knowledge representation known as the directed graph. The nodes (ellipses) stand for concepts while the arcs (the connections between the nodes) indicate the relationships between those concepts.*

The Method of Loci

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were extensively trained for it. Part of that training was in the art of memory, and the central technique was the method of *loci* (see reference 9).

To use this method you would choose some place complex enough to contain many nooks, corners, and views (that is, loci, or places)—a temple generally was suggested (see figure 4a). You would then walk through this place according to some appropriate route (see figure 4b). This memorized walk, this visuo-kinetic image, is your memory map. Whenever you want to memorize a speech you start at the beginning and associate an image related to your first idea with the first place on your map, your second idea with the second place on your map, etc. To deliver the speech you conjure up the mental map and walk through it on the standard path. As you move from place to place the ideas you had associated with each place will come back to you.

Consider, for example, the speech that Marc Antony delivered at Caesar's funeral (from Shakespeare's *Julius Caesar*, Act III, scene ii, lines 72 and following). For the first line—"Friends, Romans, countrymen, lend me your ears . . . "—Antony might have associated the image of a bunch of ears with the first locus, the first position in his walk through the temple. A skull would be a natural association for the second line—"The evil that men do . . . "—at the second position. Further lines would be linked to further loci through appropriate images.

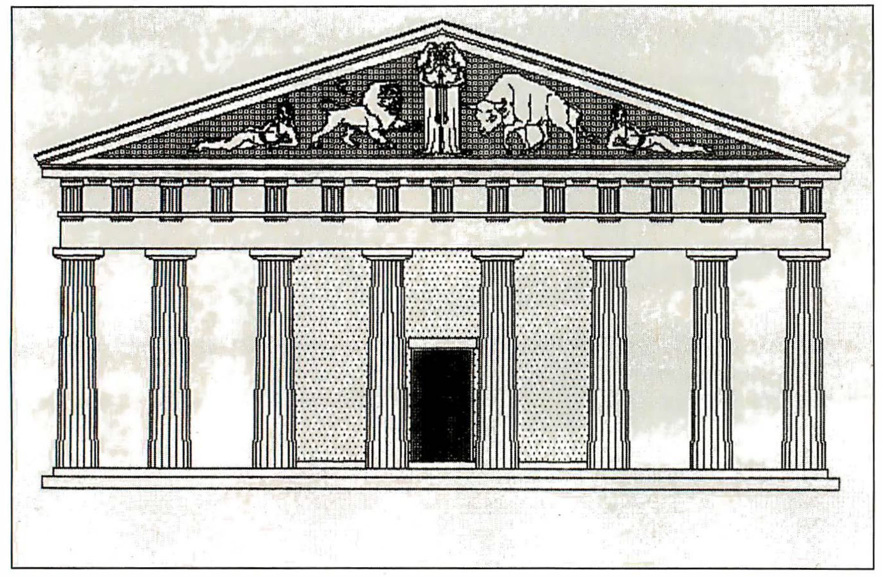


Figure 4a: A *temple. The figures on the pediment are reduced versions of figures from* McPic.

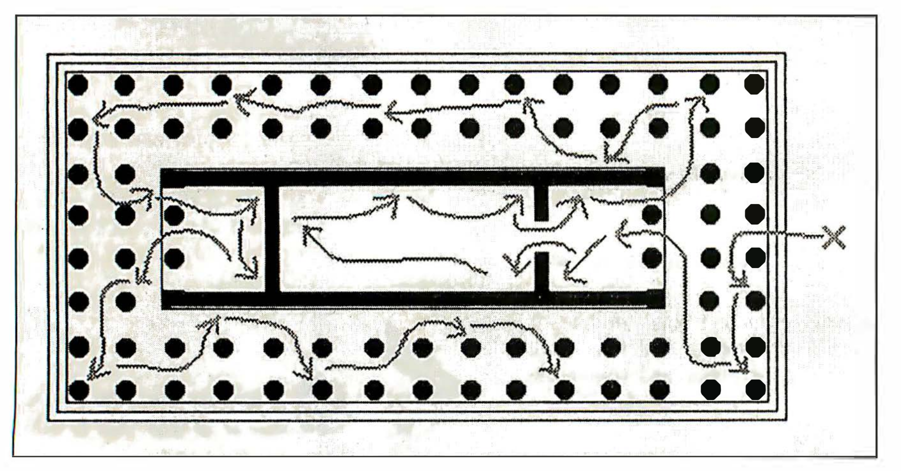


Figure 4b: A *set of loci associated, in this case, with a temple serves as a memory map.*

Just how this works we don't know. Given our current knowledge of the brain, we can speculate that loci are established in the visual hemisphere while the words being memorized are stored in the verbal hemisphere. The visual brain is used to index and retrieve the contents of the verbal brain. Instead of assigning memory locations numerical values, as in a computer, they are given pictorial values. But the basic principle is the same—one part of a complex information system is being used to index and retrieve the contents of the other.

The art of memory isn't as important to us as it was to the ancient Greeks and Romans. We have books, typewriters, and word processors (teleprompters too). But the *integration* of visual and verbal information is important to us. A well-illustrated article is easier to understand and recall because the mind has more material to work with, more external support. Good illustrations help you conjure up your own images and diagrams, making it easier to understand and absorb the material.

We all know that a picture is worth a thousand words and that there are many things that require pictures, diagrams, charts, graphs, etc., to be understood. And yet we still think of visuals as illustrating the text, when it is often the other way around. College courses in technical communication generally have a section or two on graphics but they are mostly about tables, graphs, and charts. Very little is said about pictures (whether photographs or line drawings) except that they are important and perhaps even essential.

What kind of pictures do you need?

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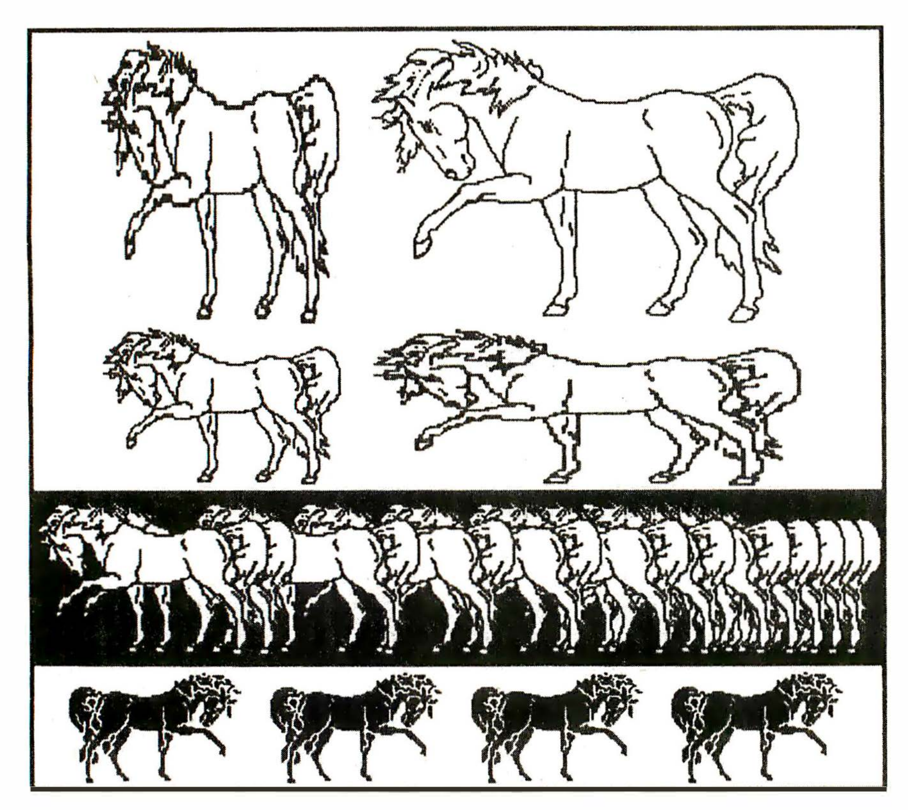


Figure 5: *Variations on a horse. The original in the upper right is preprogrammed on McPic. The variations were created using MacPaint to shorten, reduce, elongate, multiply, and reverse the image.*

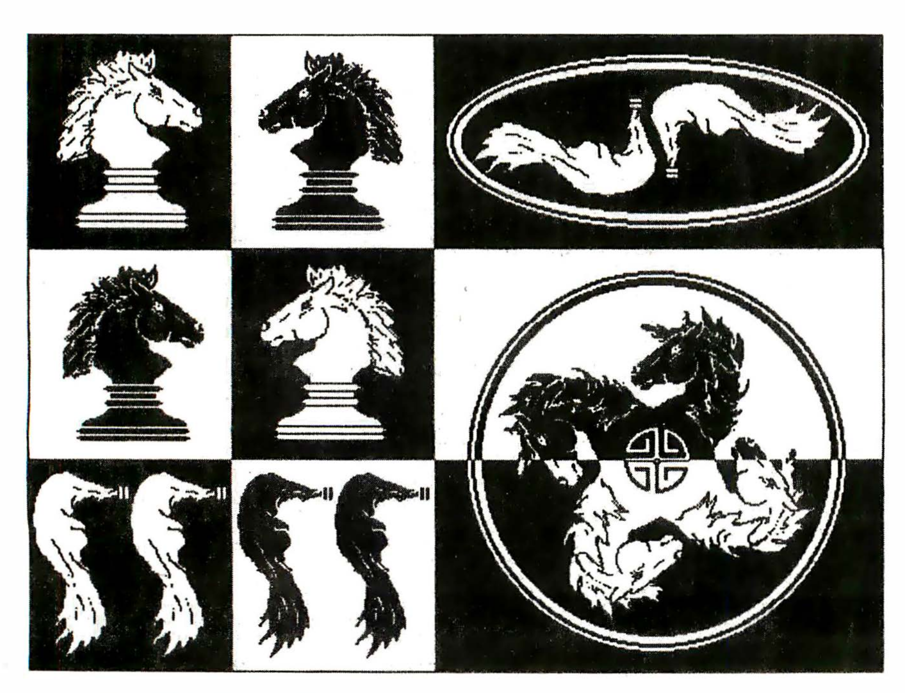


Figure 6: *Various uses of parts of the horse from figure 5. MacPaint was used to create these modifications.*

What makes them effective? When do you need them? Usually, we are taught little about using pictures and diagrams to illustrate abstract concepts (such as using the ambiguous vase/faces diagram to clarify Kuhn's concept of the relationship between scientific theory and observation). Some people know, intuitively, what sorts of pictures are good and effective, but explaining that knowledge to others is difficult. And the only people who seem to be able to depict abstract ideas are illustrators for such magazines as *Scientific American*, who have to figure out, among other things, how to make two-dimensional representations of *n*-dimensional spaces.

The main problem is that writing and illustrating are thought of as two different tasks. Some people specialize in writing, others in illustrating—but few become adept at both. Yet both images and verbal propositions are essential to thinking. This particular division of labor, in part, is caused by the difficulty of making good pictures; few people are adept at it. This brings us back to the Macintosh because its graphics capabilities can help bridge the gap.

Reconstructing Visual Images

The Macintosh isn't going to make you an artist if you can't draw a recognizable horse, but if you can use an image someone else has already prepared, perhaps you don't need to be an artist. The horse in the upper right-hand corner of figure 5 comes from McPic, one of the various disks of images that is available for the Macintosh. The other images were derived from the original horse in obvious and simple ways using tools from MacPaint.

In figure 6 the head and tail of the horse were cut away from the body, modified slightly (the mane was changed for the chessman, the left rear leg was removed from the tail), and treated as abstract design elements. In other words, the images are used as lines and shapes in a visual

(continued)

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composition and their abstract qualities as lines and shapes are more important than the fact that they represent parts of a horse. These manipulations are easy to do in MacPaint. And once you start doing them you are on the way to developing your own drawing skills.

To draw well, you must learn to see the visual world in terms of lines and shapes, not simply in terms of objects; you must draw what your eye sees, not what your mind makes of what your eye sees (reference 10). Consider the nature of perspective drawing. In figure 7a, which shows the view looking up a temple column, your mind knows that the columns are only slightly tapered. But that is not what your eye sees from this point of view. Figure 7b shows the forms the columns present to your eye from this particular point of view. The trick is to get your drawing hand to override what your mind knows in favor of what your eye sees.

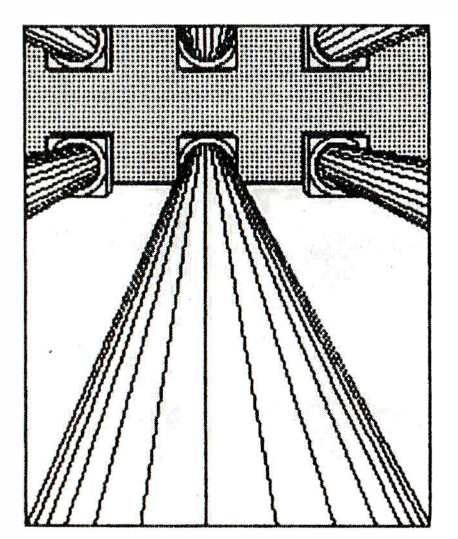


Figure 7a: *The view looking up a temple column. Note the intense foreshortening.*

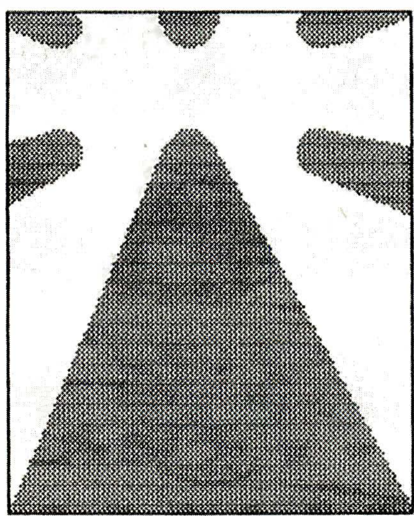


Figure 7b: *This shows the basic forms presented in figure 7a.*

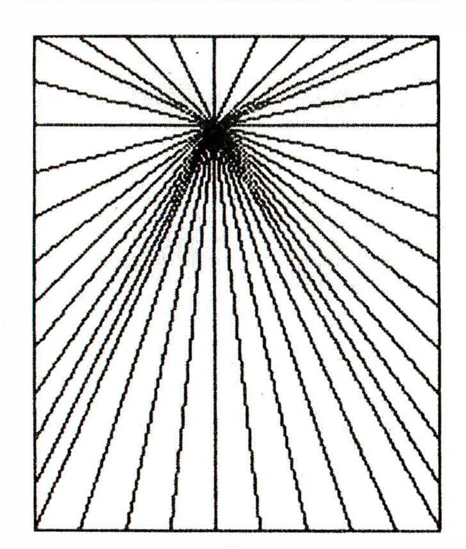


Figure 7c: *The vanishing point of the example in figure 7a.*

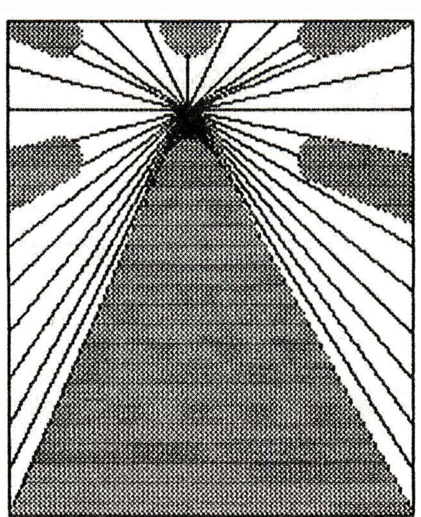


Figure 7d: *The basic column forms from figure 7b superimposed on the perspective grid given in figure 7c.*

Your drawing hand must override what your mind knows in favor of what your eye sees.

The best way to learn perspective drawing is to study the tricks developed during the Renaissance. Figure 7c shows a bunch of lines radiating from the vanishing point (the point on the visual horizon where your gaze is focused). All lines in the image space that are perpendicular to the picture plane pass through the vanishing point. Figure 7d shows the forms of the columns superimposed on the perspective grid. By using an explicitly constructed perspective grid, you can overcome what your mind knows and, instead, draw what your eye sees.

The techniques of perspective drawing didn't just happen. They were painstakingly created over a period of centuries ending about 400 years ago. And they were created at the same time that projective geometry was being developed—in some cases by the same people (see reference 11). Thus, artists used projective geometry to help them reconstruct three-dimensional images on the two-dimensional space of the picture plane. The mental process involved in drawing is quite different from that in which the mind comprehends what the eye sees. To draw a picture of an object you must reconstruct what your eye will see in terms of hand and pencil motions (see reference 12). By making it easy to treat pregenerated images as abstract design elements, the Macintosh starts you along the road to this reconstruction. The essential first step is to see lines and forms, not objects. When you play with MacPaint it is quite clear that you are manipulating lines and forms, and that you are dealing with purely visual objects, not just representations of cars, horses, trees, buildings, etc.

(continued)

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To generate a circle with a compass, you select the center point and rotate a radius around it. To generate the circle with MacPaint, you select a point to be the corner of an invisible square in which the circle will be inscribed and drag the mouse diagonally across to the opposite corner. In the compass and straightedge method, the center plays an important role. With MacPaint, it does not. The world of MacPaint is different from the world of compass-and-straightedge geometry; hence an act of reconstruction is required if you wish to mimic compass-and-straightedge geometry in MacPaint.

Listing 2 shows a bit of Logo code that constructs an equilateral triangle. The meaning of the code is not important here. What is important is that it is clearly propositional. The compass-and-straightedge method and MacPaint are visual—more exactly, visuo-kinetic. But computer code is clearly propositional. A computer language, though quite different from a natural language, is verbal and, therefore, is in some sense a propositional reconstruction of a visual object.

Simple geometrical figures are not particularly exciting, but consider moiré patterns (figure 8). You can easily construct them with MacPaint. And once you've spent a day or two playing around with them, you'll want to write short programs to generate them. Drawing all those lines is easy enough, but it's tedious: why not let the computer do it? But to do that you have to learn to program the computer, to make propositional reconstructions of visual objects.

Years ago Alan Kay said that working in a visual computing environment provides a natural incentive for learning to program (reference 13). The graphics power that makes the Macintosh so user friendly also provides an incentive for users to learn enough about programming so that they no longer need that user friendliness. But it is MacPaint that provides this incentive, not the icon-based interface. It is possible that Apple's efforts to produce a computer for people who know nothing about programming (and don't want to learn) may well inspire an increase in the number of such users who *do* learn to program.

Perhaps we need a revised conception of user friendliness. A user-friendly computer should not be one that lets you use it despite your ignorance; it should provide you with an incentive for learning how to program it. The Macintosh meets this criterion.

Working in a visual computing environment provides a natural incentive for learning to program.

Listing 2: *Constructing an equilateral triangle in Logo. The four lines of code at the top specify a procedure for drawing polygons. The procedure has two parameters, the length of a side (size) and the angle through which the Logo turtle must turn to move from drawing one side to drawing the next side. The line at the bottom specifies a side of 74 units and an angle of 120 degrees.*

```
TO POLY :SIZE :ANGLE
FORWARD :SIZE
RIGHT :ANGLE
POLY :SIZE :ANGLE

POLY 74 120
```

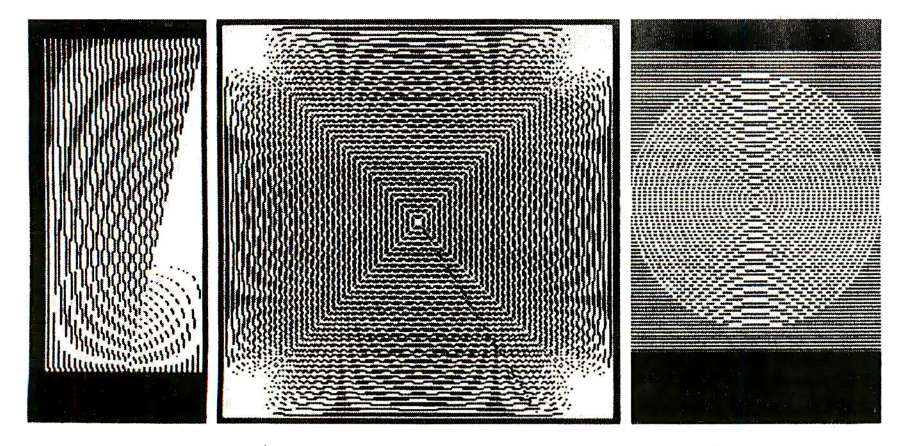


Figure 8: *Various moiré patterns created on the Macintosh with MacPaint.*

THE MACINTOSH EMERGES

By now I hope it's obvious that I am attempting to produce a gestalt switch in the way we think about the Macintosh. In terms of figure 2 it was designed as an ambiguous figure and marketed as two men staring at each other. I suggested that we look at it as a flower-filled vase. If you consider personal computers, some are business machines, some home machines, and some are both.

Business machines are used for word processing, accounting, financial modeling, inventory control, etc., and, if you allow for the necessary peripherals and software, they are likely to cost between $3000 and $20,000. They will probably have a 16-bit microprocessor (or perhaps 32-bit), 128K to 512K bytes of RAM (random-access read/write memory), a hard disk, and compilers or interpreters for

(continued)

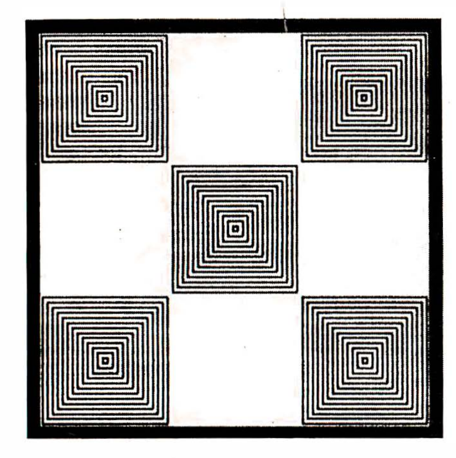


Figure 9a: *This drawing represents the various niches that make up the personal computer marketplace.*

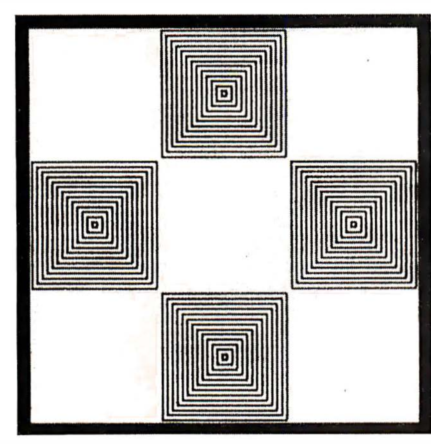


Figure 9b: *Imagine that these are the various computers destined to fill the niches in figure 9a.*

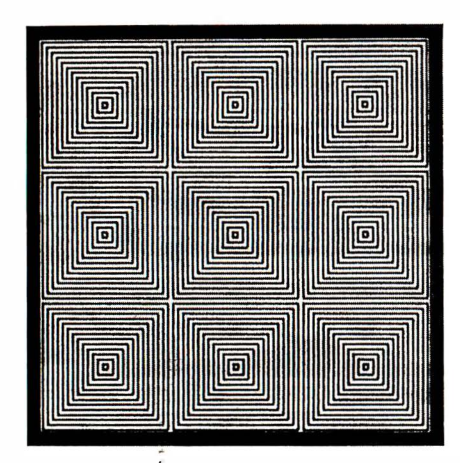


Figure 9c: *This represents the personal computer marketplace; the square holes, the interaction between the niches in figure 9a and the computers in figure 9b. Notice that this interaction creates patterns of diamonds that don't exist in either of the constituent patterns when considered separately. These are called emergent patterns.*

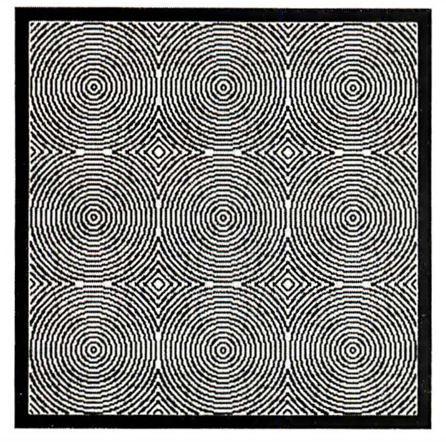


Figure 9d: *The differently patterned Macintosh—the round peg.*

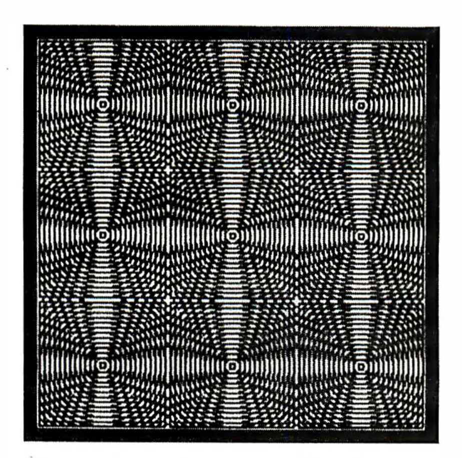


Figure 9e: *When you combine the round peg (figure 9d) with the square hole (figure 9c), something genuinely new emerges—jazzy squares.*

various programming languages.

Machines for home use tend to be much smaller. They cost between $300 and $1500 and use a color TV as a monitor. Mass storage is often a tape cartridge. These machines may run the same types of applications as their business-like siblings and in the same languages, but they are more likely to be used for video games and educational programs for the kids.

Figures 9a through 9c contain an abstract representation of the personal computer marketplace. There are certain niches (figure 9a) for all these machines (figure 9b) and they fit perfectly (figure 9c). Those who use microcomputers are generally doing well in their businesses and their kids have a ticket to the future. Those who manufacture and sell the machines are getting rich. When you put the two together, diamonds result from the interaction of two patterns, neither of which contains diamonds. The diamonds are an emergent pattern.

Consider the Macintosh, a differently patterned machine that doesn't fit into this picture at all (figure 9d). It doesn't yet have the power necessary for business computing. It is a lot of fun to use, but it is expensive for home users. And yet it is selling well. Who is buying these machines and what are they doing with them? If you combine this differently patterned machine (figure 9d) with the world of personal computing (figure 9c), you will find a new pattern—jazzy squares (figure 9e). Something genuinely new has emerged out of the interaction.

The Macintosh doesn't fit into any of the current categories of personal computing. It is designed, marketed, and reviewed (for the most part) as one more personal computer that does the standard things that personal computers do. The differences are: it has this easy-to-use icon-based interface; you don't really need a manual, just turn it on and start "mousing" around; and there is this program called MacPaint that's fun to use.

People like to draw, and working with MacPaint is fun. It gives you a

(continued)

THE VISUAL MIND

MacPaint actively involves you with the computer. The Mac is easy to use—and it is fun.

much more active involvement with the computer than word processing or a spreadsheet program does. This involvement can lead you into programming. It can lead to deeper thinking and more effective communication. It is easy—and it is fun. ■

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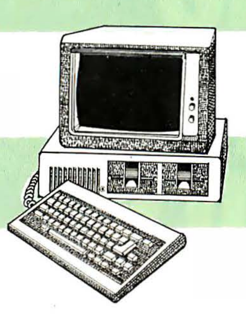
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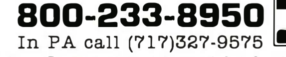
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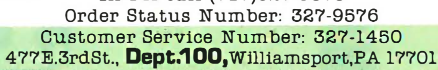

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Inquiry 2

BY JOSEPH S. NADAN

A GLIMPSE INTO FUTURE TELEVISION

A technology evolving in parallel with personal computers

Editor's note: How will high-definition television (HDTV) open the window on the world for users of personal computers? This article presents the technical possibilities and describes a scenario for the evolution of television in the "information age." The author explains the relationship between HDTV and two-way interactive cable television (CATV). As envisioned, HDTV will have wider computer-type displays with increased resolution. This could support the preparation of larger spreadsheets using databases located both inside and outside the home. Shop-at-home services could benefit from "video facsimile," the ability to send a picture from one location to any other on a CATV system in about 1 second. We could see what we are interested in buying, rather than viewing simple graphical representations.

When used as an entertainment device, the future television receiver probably will be very different from that of today. The author discusses new features made possible by digital memory within the receiver. We'll be able to watch more than one program at once and use our personal computers while also watching, for example, one or more sporting events. Or we could shop interactively while watching a movie. When operated in high-definition mode, the larger and wider picture could enable the viewer to experience a theater-like presentation.

Color television has been in the American household for about 30 years. It is somewhat ironic that the television industry, the storehouse of creativity that has stimulated the development of VLSI (very-large-scale integration) digital video memories and significant improvements in rear-projection displays, is having so much difficulty in making the transition into the "information age." The cost, reliability, styling, and picture quality of color television have vastly improved over the years. However, color television still has its original display shape and one-way receive-only capabilities.

TELEVISION IMPROVEMENTS

The next generation of television receivers, in order to gain our acceptance, will most likely have

- a large display area with a wider aspect (width to height) ratio
- flexibility and interactivity
- approximately twice the perceived horizontal resolution and vertical resolution of NTSC (National Television System Committee) television
- true high-fidelity stereophonic sound (not discussed here)
- no artifacts (visible effects on the display; for example, shimmer and color flashing) that were not present in the original scene

Because of economic, social, and technical considerations, we at Philips Laboratories believe that the optimum maximum size of a consumer display will be about one-half square meter. While researchers still work toward very large flat-panel displays, it appears that vastly improved rear-projection displays are more imminently practicable. It is possible that in the next few years we will be able to purchase rear projectors that will have better subjective performance in normal room lighting than the 26-inch direct-view cathode-ray tubes (CRTs)

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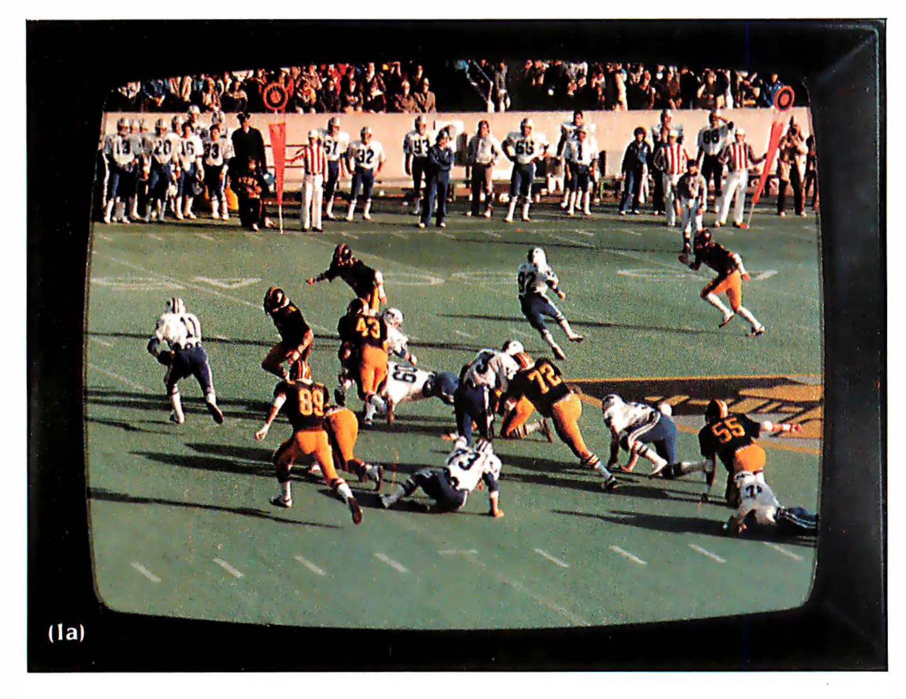
Joseph S. Nadan (345 Scarborough Rd., Briarcliff Manor, NY 10510) is director of electronics and optical systems research for Philips Laboratories, a division of North American Philips Corporation.

that are in use today.

A second important display parameter is the aspect (width to height) ratio (see the glossary on page 151). To more closely match the aspect ratio of human vision (1.80:1) and to better match film material, which is predominantly 1.66:1 and 1.85:1, we suggest an aspect ratio of 5⅓:3 (or 1.78:1) in place of the standard 4:3 (see photo 1). We selected 5⅓:3 over 5:3 because it is more noticeably different than 4:3. (Note that 5:3 is a 25 percent increase in width over 4:3 while 5⅓:3 represents a 33 percent increase over 4:3.) It also supports new features made possible by digital memory in a television receiver.

Digital Memory

The availability of a low-cost digital memory within a television receiver makes possible new features, including both local- and network-level interactivity. (See the text box "Memory Technology for Digital-Feature Television" on page 148.) Digital signal processing within the receiver may be broadly classified into two categories: those that provide new features and those that replace existing analog signal processing at lower cost. Digital memory in the receiver falls into the first category and provides these new features: multiple-picture-in-picture (MPIP) display, single-picture-in-picture display, and frame storage (freeze-frame).



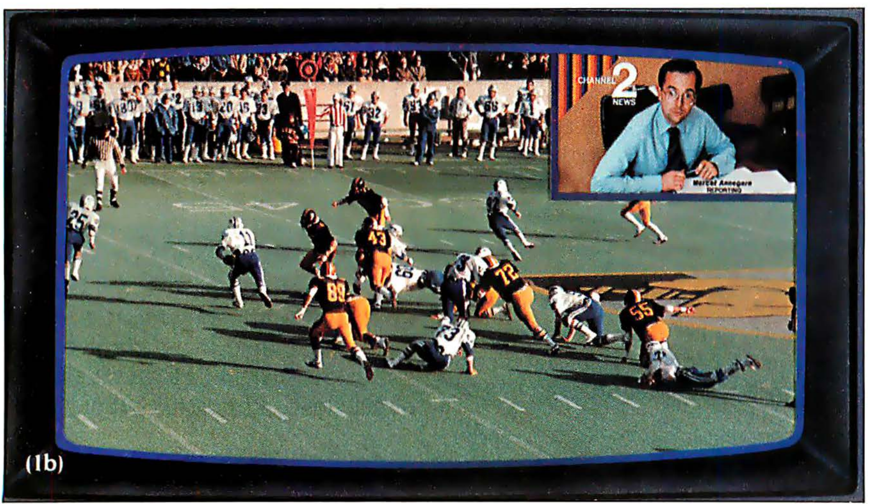


Photo 1: *A comparison of the standard* 4:3 *aspect ratio* CRT *(a) and the proposed* 5⅓:3 *version (b).*

When first powered on, the new receiver could show 12 channels—that is, multiple pictures in one display (see photo 2)—to enable us to preview what is "on the cable." This display could also indicate the programming mix; that is, those programs available in an HDTV format could have a flashing contrasted dot as an indicator mark. By pressing one button on the remote-control unit, we could choose another set of favorite channels (which we have previously loaded into the receiver). After using an MPIP preview, we could select one or two programs to watch in real time (see photo 1b). For example, we might want to watch two sporting events simultaneously, switching the more interesting programming to the larger portion of the display almost instantaneously by pressing one button. We could also watch one main program while "clicking through" other programs on the smaller display area. We also will be able to store a picture in memory and retain it on the display for closer viewing later.

The 5⅓:3 aspect ratio is special in the respect that it synergistically relates to 4:3; in other words, one 5⅓:3 picture may be formed from one 4:3 picture and three smaller 4:3 pictures. These capabilities may be combined for great flexibility. For example, we could use our personal computers while watching three different broadcasts. Preparing a wide spreadsheet or any type of document that is horizontally oriented is also facilitated by this aspect ratio.

Interactivity

A conventional CATV network consists of a head-end facility broadcast-

ing perhaps 30 channels into several trunks, each having a bandwidth of about 400 MHz. These are then bridged into branches, split into subbranches, and tapped into perhaps 10,000 homes. Several immediate consequences come to mind: a vast underutilization of bandwidth; no interactivity except for a few "experiments" like QUBE (even QUBE interactivity is responsive in only one way: from the home to the head end); and a large investment in installed plant, including the head end, cable, distribution amplifiers, etc.

When two-way network-level interactivity is available, we will be able to send data from our location to any other location on the system. We could watch one program on the large portion of the display, two smaller programs on the small displays, and use the remaining small display to monitor our electronic mail. Figure 1 illustrates a distributed interactive CATV system having this two-way network capability. When we want to interact with the head-end facility, we first communicate via an access method with the nearest upstream video switch. This switch determines the type of data and its destination. Routing of traffic in this system is much simpler than in a packet-switching system because of the limited number of choices (upstream, downstream, return to same branch, and channel to be used). For this example, video switch 1 routes the message upstream using network-level protocol to video switch 0, which converts the RF (radio frequency) message to baseband for serial input to the head-end computer. The return message follows an analogous path to the origination address.

The distributed nature of the network enables users 7 and 8 to interact via video switch 2 without affecting communication with the head end. In this manner, average throughput of the network may be increased and average message delay minimized; when traffic and revenue warrant further investment, the system operator can install more switching at appropriate nodes to improve the network.

Each video-switch node also could contain memory for user applications. This would serve two purposes. First, many messages would be highly correlated, hence system performance may be improved. For example, at 7:55 p.m. it is reasonable to anticipate that many messages would request broadcast programming information. Answers could reside at the nearest installed video switch to minimize trunk traffic. Weather, road conditions, news, and other information could be similarly located. The second purpose for "application memory" involves storing large amounts of information for users, as more fully explained in the next section.

User-to-User Video Facsimile

Because the receiver will be able to store digitally frames of information (pictures or data) and communicate between any two users on the system, video facsimile is possible. Using this capability, a user can send *one* picture to any other user on the system with a similar interface capability. It must be emphasized that this is not real-time video (continuously sending one frame after another, each frame taking 1/30 second) but rather the transport of one single frame between destinations in about 1 second. An example is offices transporting documents between different locations on the system.

Perhaps shop-at-home services would become economically viable when high-quality video pictures that would take about 1 second to transmit over a cable TV network replace cartoon-like "pictures" that take tens of seconds to transmit over telephone lines. After all, we like to "see" what we are buying.

It is unreasonable to expect people to manually input each frame if they want to participate in multiple-request interactive services. Fully automated interactive service will require multiframe storage capability. This should be economically viable, could be used to provide responsive information to all users of the network, and may be located conveniently at the bridge nodes or video switches.

Firmware

Reliable operation of both the receiver/set-top converter and the network switches will require well-developed firmware. This should not be difficult to obtain because equipment manufacturers have considerable experience in these areas. The receiver's remotely controlled tuner already operates under the control of a micro-

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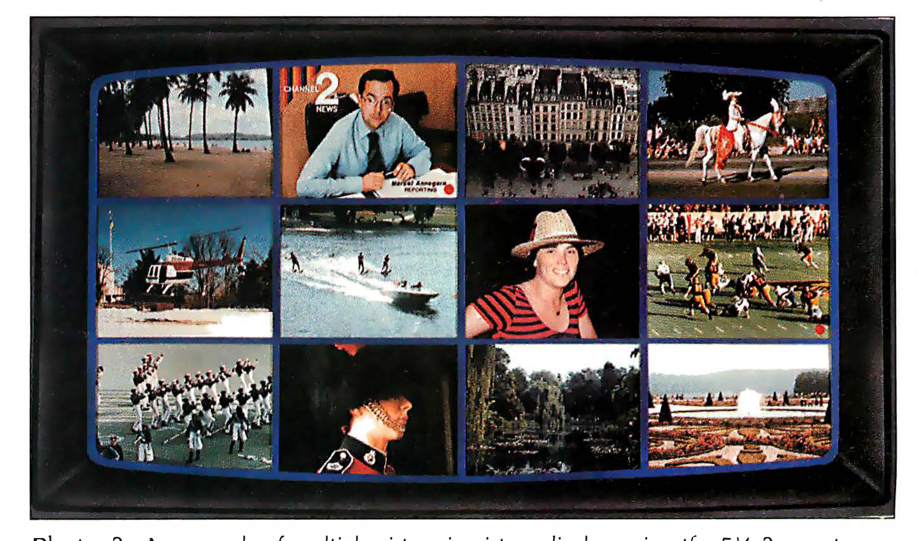


Photo 2: *An example of multiple-picture-in-picture display using the 5⅓:3 aspect ratio CRT. The red dots in the two corners of the small windows indicate high-definition television display availability.*

processor. Some addressable CATV set-top converters have as many as three microprocessors. These use a token-passing scheme to gain access to a shared NOVRAM (nonvolatile random-access read/write memory with a back-up array of electrically erasable programmable read-only-memory cells) that stores channel requests, favorite channels, and other control information. Packet switches typically have used the most modern technology; design of video switches will most likely include 32-bit microcomputers.

It is important to emphasize that the video switch also most likely will have extensive mass-storage capability and perhaps even will include many videodisc storage systems. Firmware will have to be developed to support the single-frame queries of hundreds of users to a given videodisc database in a manner that will not noticeably degrade the performance of the system.

Picture Quality

The subjective quality of a picture is determined partly by its vertical resolution, horizontal resolution, and artifact content. The vertical resolution of a picture is defined as the number of horizontal lines that may be seen in one picture height. This depends on the number of lines actually scanned across the display, the quality of the "spot" scanning each line, and our ability to perceive the light that is produced. In the current NTSC system, 525 interlaced lines are transmitted 30 times per second. Only about 480 of these lines appear on the display, 240 in each 1/60th-second interlaced field. The remaining "lines" are not shown on the display and occur during the vertical flyback interval. This is the time required for the scanning spot to travel from the bottom to the top of the display and is necessary for the receiver to synchronize the picture scan to the proper position on the display. The vertical resolution may be represented by the relationship $V = K_d N_a$, where V is the vertical resolution, K_d is the display factor, and N_a is the number of "active" lines.

The horizontal resolution of a picture is defined as the number of vertical lines that may be seen in a width of the picture equal to the picture height. This is primarily determined by the maximum frequency at which the spot scanning each line may be modulated (turned on and off). In the NTSC system this frequency is 4.2 MHz, although many color television receivers restrict this value to about 2.5 MHz, as explained later.

Artifacts are visible effects on the

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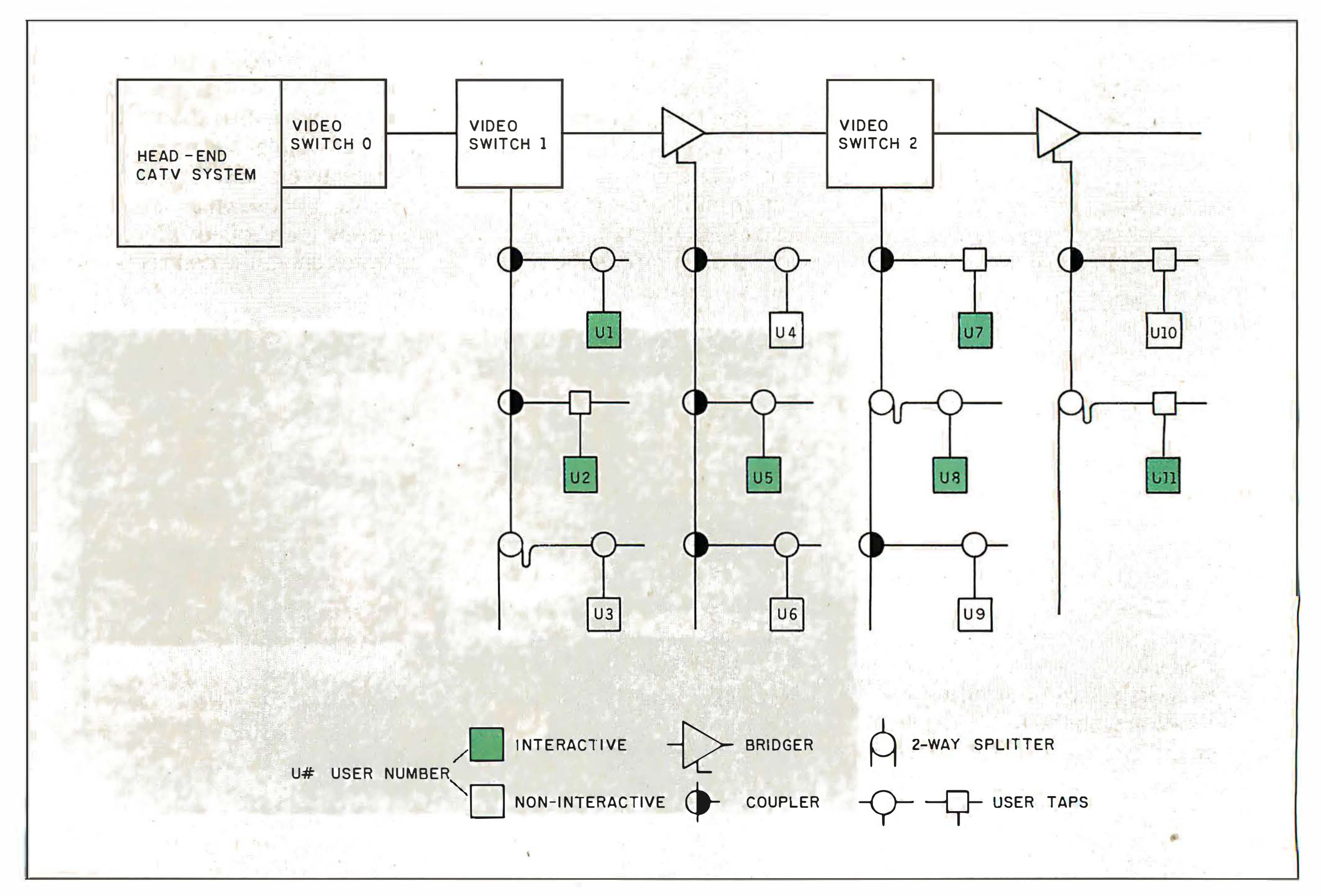
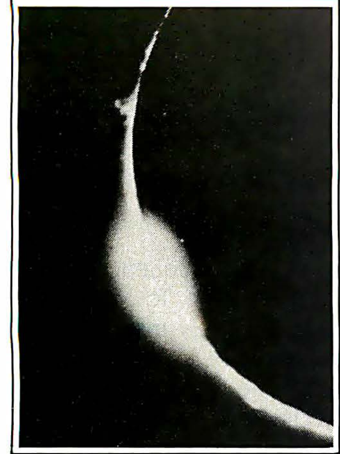


Figure 1: *An example of a two-way interactive cable-television system.*



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display that were not present in the original scene. They are caused by the manner in which a scene is encoded for transmission and the way it was originally sampled and then displayed. The most common are

- cross color, in which narrowly spaced lines break out into a rainbow of colors; striped shirts and windows on a building, for example, often become more colorful in certain areas due to this effect
- cross luminance, in which sharp vertical color transitions and large saturated color areas appear to have small moving dots
- large-area flicker, in which very bright areas seem to flash on and off at the 60-Hz field rate
- line flicker, in which stationary edges that are not perfectly horizontal appear to move slightly up and down (or twinkle)
- line crawl, in which certain vertically moving objects lose about half their vertical resolution due to the interlaced display

In an attempt to minimize transmission bandwidth, the NTSC encodes chrominance and luminance information within the same bandwidth. Hence, the bandwidth from about 2.3 to 4.2 MHz is shared; the luminance information is centered on frequencies that are a multiple of the line frequency, while the chrominance information is offset by half the line frequency from these values. Successful decoding of the chrominance and luminance signals requires true separation of this frequency-interleaved information. To decode luminance inexpensively, many manufacturers separate the signals by low-pass filtering the luminance. This limits the horizontal resolution rather severely but eliminates the cross-luminance artifact. Line comb filters make it feasible to extend the horizontal resolution to the NTSC limit of 4.2 MHz with reduced cross effects.

Improved Picture Quality

Picture quality may be improved by increasing vertical or horizontal resolution and encoding the information in a different way that precludes cross effects. At Philips Laboratories we have shown that the subjective picture quality of an NTSC signal could be improved further by the use of digital picture-store memories in the receiver without changing the transmitted signal. Motion-compensated interlaced-to-sequential scan conversion demonstrates that perceived vertical resolution could be increased and line flicker eliminated. Figure 2 illustrates the interlaced scanning of normal NTSC television. If the transmitted lines are represented by X, the user sees the Xs in field 1 during the first sixtieth of a second (lines one, three, five, seven, etc.) and the Xs in field 2 during the second sixtieth of a second (lines two, four, six, eight, etc.). This alternate-line scanning repeats every other field.

With our approach, the transmitted signal format is not changed at all, but the alternate lines (represented by Os) that would appear in field 2 are stored in the receiver by spatial and temporal interpolation, and then all the lines are scanned in sequence rather than being interlaced. This technique results in a quiet appearance (with no line flicker) of the sequential display and an apparent increase in vertical resolution.

As illustrated in figure 3, the most striking effect is a noticeable reduction in the visibility of line structure. We are "misled" into believing that the number of transmitted lines has been doubled from 525 to 1050. The

(continued)

FIELD 1 — LINE 1, LINE 3, LINE 5, LINE 7 — TIME
FIELD 2 — LINE 2, LINE 4, LINE 6, LINE 8 — $\frac{1}{60}$ second
FIELD 1 — LINE 1, LINE 3, LINE 5, LINE 7 — $\frac{1}{60}$ second

Figure 2: *The sequential-scan conversion process. X indicates a transmitted line; O indicates a locally interpolated line. The solid green line indicates line average (motion), green dashes indicate picture average (still), green dots indicate field insertion (still).*

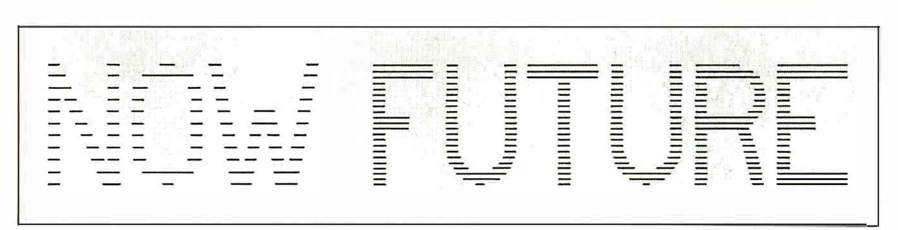


Figure 3: *Line structure visibility. There are twice as many horizontal lines in the sequential-scan representation.*

transmitted signal remains unchanged (525 lines 30 times per second) but has its perceived value increased by conversion for display at 525 lines 60 times per second.

SEQUENTIAL SCAN CONVERSION

Three methods can be used to convert a transmitted interlaced-scan signal to a displayed sequential-scan signal. *Line averaging* displays double the number of lines of information per picture but reduces the vertical resolution. However, line structure visibility is reduced without introducing artifacts on moving parts of the picture. Line flicker, however, is not eliminated by line averaging. *Picture averaging* (or *field insertion*) combines the information of all lines of both fields to preserve the vertical resolution and eliminate line flicker. However, in moving scenes, the relatively large time difference between the two fields produces jagged edges on moving contours. A third approach combines the previous two and adds *motion-detection* circuitry.

R. Prodan, of our laboratory, has demonstrated motion-detection circuitry that switches between the two methods to avoid new artifacts created by the scan-conversion process. Line-averaged and field-delayed information is combined in a complementary way based on the amount of motion in each picture element. A gradual switching from one interpolation technique to the other minimizes the visibility of the switching process. The scan conversion is accomplished by digitizing the composite video signal. Two field memories are used with the digitized input signal to provide the three fields of information needed to produce a motion-adaptive sequential-scan conversion. In this way, displayed picture quality is improved without introducing any new scan-conversion artifacts.

HDTV SYSTEM CONSIDERATIONS

The fundamental relationship between the various factors that may be improved in a television picture is

$$R_H R_V R_W = N_C \frac{D_n}{D_o}$$

where R_H is the horizontal-resolution improvement factor, R_V is the vertical-resolution improvement factor, R_W is the width improvement factor, N_C is the number of channels used, and D_n and D_o are the display factors of the new and old systems, respectively. Of particular interest are two-channel sequentially displayed systems for which $N_C = 2$, $D_n \approx 0.8$, and $D_o = 0.5$.

Doubling the perceived vertical resolution of an NTSC display may be ac-

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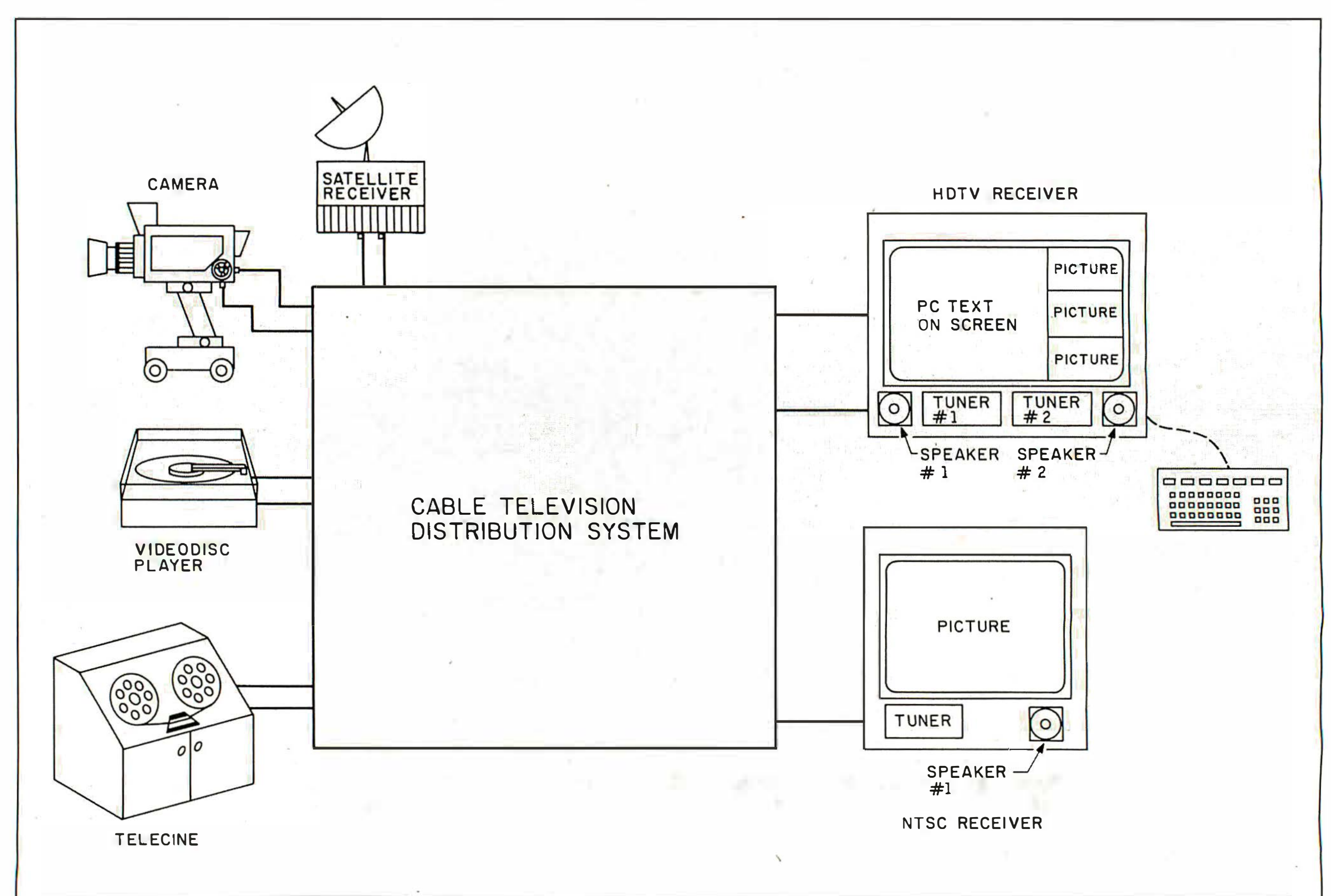


Figure 4: *A block diagram of a two-channel high-definition television system.*

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complished by simultaneously increasing the number of lines *and* the display factor. Because the required bandwidth of a system increases in proportion to the square of the number of lines, it is preferable to use the minimum number of lines in an HDTV system. Hence, an 1125-line *interlaced* display has a perceived vertical resolution of about 562 lines, while a 657-line *sequential* display has a vertical resolution of 526 lines while using only $(657/1125)^2$ = 34 percent of the bandwidth. It is possible, therefore, to double the perceived vertical resolution of an NTSC display by increasing the number of lines from 525 to 657, transmitting this interlaced signal, performing an interlaced-to-sequential scan conversion in the receiver, and finally displaying the result sequentially. For a 5⅓:3 aspect ratio (R_w = 1.33) two-channel system, this results, however, in only a 20 percent increase in horizontal resolution.

Another point to consider is available transmission bandwidth. A straightforward doubling of the number of lines from 525 to 1050, increasing the width from 4:3 to 5⅓:3, and doubling the resultant signal bandwidth would require 5⅓ times the single-channel bandwidth. By increasing the display factor and increasing the number of lines from 525 to 657, the required bandwidth is reduced to only 3⅓ times the single-channel bandwidth.

These two approaches are unacceptable because they use an excessive amount of bandwidth. The two-channel 657-line system offers only a 20 percent improvement in horizontal resolution; doubling the horizontal resolution would require 3⅓ times the NTSC bandwidth. We feel that these problems may be overcome by better matching the transmitted television signal to the properties of human vision.

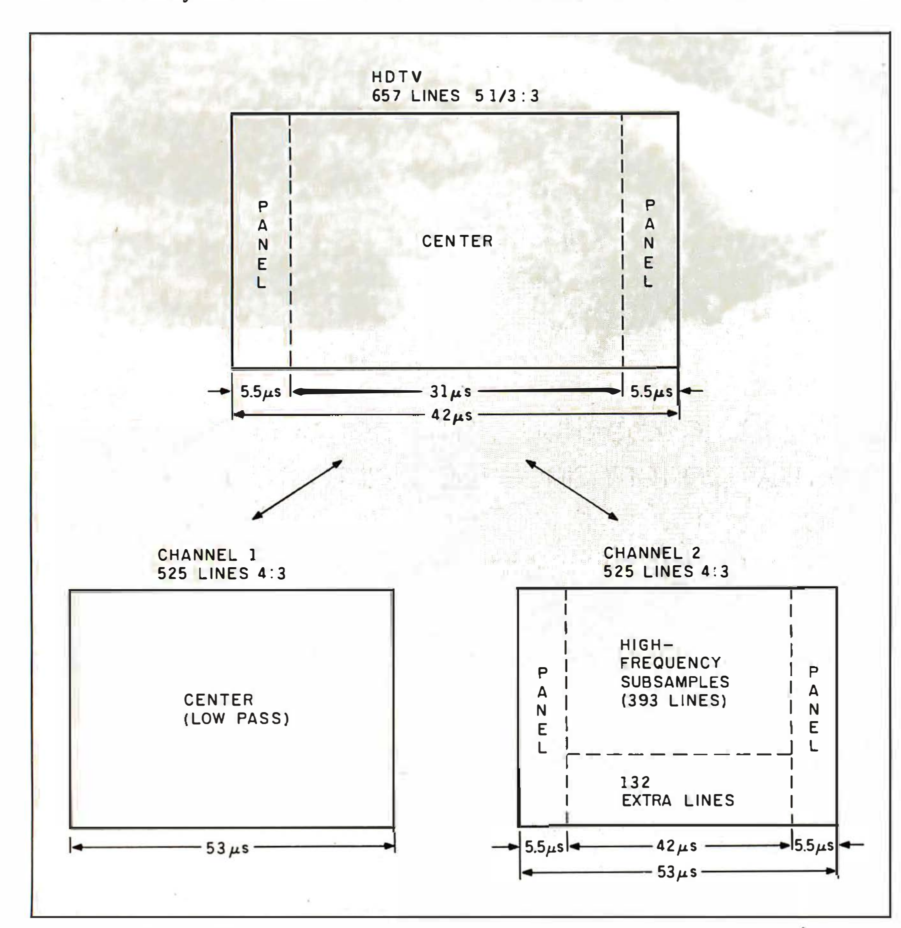


Figure 5: *A possible method for delivering a two-channel NTSC-compatible high-definition television transmission.*

Psychovisual Enhancement

Drs. William Glenn and Karen Glenn at the New York Institute of Technology have shown that it requires a finite time to perceive changes in images. Although the exact relationship is complex and not completely understood, the general principle is that the difficulty in perceiving an image increases as its subtended spatial angle decreases and/or its rate of motion increases. The operational impact is that it is unnecessary to transmit the high spatial-frequency information in pictures at the standard rate of 30 frames per second (fps). The required transmission bandwidth may be reduced significantly without affecting the perceived horizontal resolution by transmitting low spatial-frequency information (below 4.2 MHz) at the standard rate and refreshing high spatial-frequency information (above 4.2 MHz) below the standard rate. This, of course, requires digital memory in the receiver so that the 60-Hz field rate sequential display may have the full horizontal resolution composed from the previous few fields. The doubling of horizontal resolution at 30 fps, which normally increases bandwidth requirements by a factor of 20/15, may be reduced by a factor of 5 to 4/15. A two-channel HDTV system having about twice the perceived vertical and twice the perceived horizontal resolution of NTSC television may be realized by transmitting the higher frequencies at an equivalent of only 6 fps.

Two-Channel NTSC-Compatible HDTV

In a two-channel NTSC-compatible HDTV, signal sources may be distributed over a cable system to either present NTSC receivers or new HDTV receivers (see figure 4). In this manner producers, distributors, and equipment manufacturers will be able to continue to operate as the evolu-

(continued)

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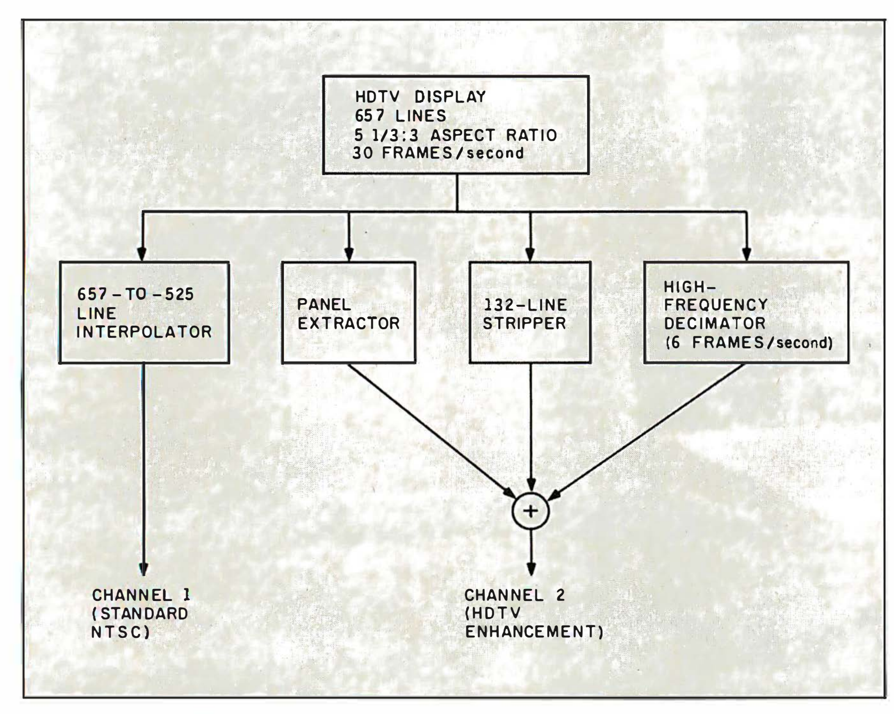


Figure 6: A *block diagram of two-channel decomposition.*

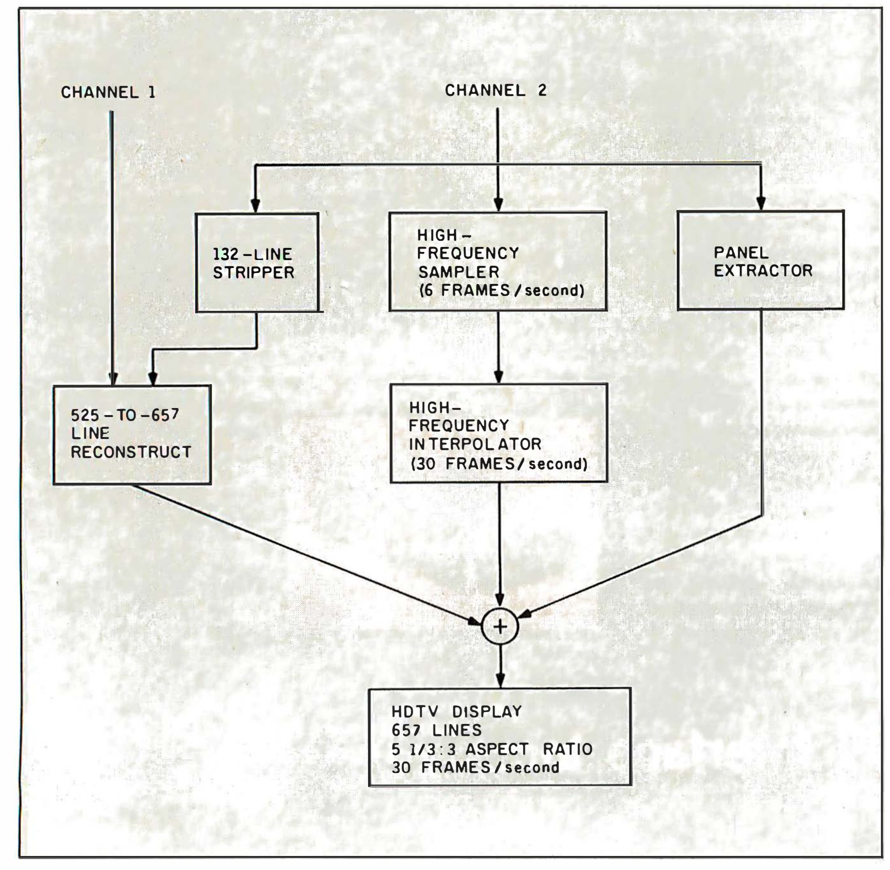


Figure 7: A *block diagram of two-channel reconstruction.*

tion toward HDTV occurs.

Figure 5 shows one possible method of delivering this HDTV signal over two standard NTSC channels. This approach separates the HDTV signal into a standard NTSC channel (channel 1) and an augmentation channel (channel 2). Channel 1 contains the "center" 4:3 aspect ratio portion of the HDTV picture that has been low-pass filtered to 4.2 MHz horizontally and converted from 657 to 525 lines by a vertical filtering operation. This signal can be displayed on all current NTSC receivers. Channel 2 contains 132 of the original 657 lines, the side panels for the 5⅓:3 aspect ratio display, and the high-frequency information for the entire 5⅓:3 picture in the remaining 393 lines between the side panels. The side panels and 132 extra lines are low-pass filtered to 4.2 MHz. The high-frequency subsampled information is shifted into the same 4.2-MHz low-pass region by a filtering and sample-rate conversion process. This signal also can be displayed on all current NTSC receivers.

Figure 6 is a block diagram of the two-channel decomposition. The 657-to-525 line interpolator produces the horizontally low-pass filtered 525-line NTSC picture from the 657-line wide-band, wide-aspect ratio source. During this process, 132 of the original 657 lines are low-pass filtered and inserted into channel 2. This information represents a linear transformation of the original 657 lines, which makes the procedure reversible at the HDTV receiver.

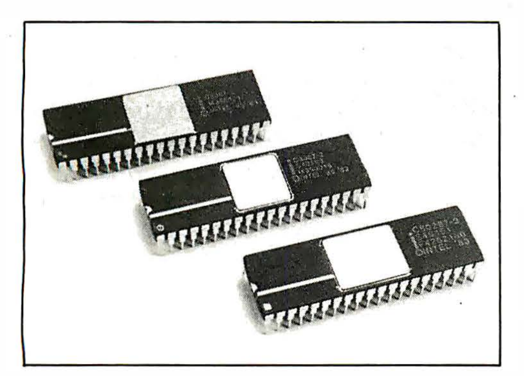
The panels outside the normal 4:3 center portion are extracted after a 525-line interpolation and similarly inserted into channel 2. This permits reconstruction of the 5⅓:3 aspect ratio low-pass information at the HDTV receiver. The high spatial-frequency information is subsampled temporally at a 6-fps rate, shifted to the baseband low-pass frequency region, and inserted into the 393 remaining lines between the panels in channel 2. The two channels are transmitted simultaneously over two

(continued)

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separate NTSC channels. Standard receivers would receive either of these; the channel 1 signal is the equivalent of the present transmission, the channel 2 signal is recognizable as the extra information necessary to build the perceived better picture.

Figure 7 is a block diagram of the two-channel reconstruction. Channel 1 carries the center portion of the wide-aspect ratio picture. The side panels are extracted from channel 2 to give a 5⅓:3, 525-line low-pass picture. The extra 132 lines are stripped from channel 2, and a linear transformation yields the original 657 lines in the low-pass region of standard NTSC horizontal resolution. The high-frequency information is extracted from channel 2, shifted up to the original high-frequency region to refresh a digital memory frame store that receives the information over the channel at 6 fps. The frame store is continuously read out at the standard 30-fps rate. This increases the perceived horizontal resolution to double the standard NTSC resolution for still pictures. Horizontal detail will have lower temporal resolution due to the subsampling. The eye is less sensitive to fine detail that's moving; we will not perceive this loss in "theoretical" resolution.

Non-Shared Bandwidth Systems

A digital frame memory in the receiver enables further improvements in picture quality. The noise performance of the receiver may be improved about 3 decibels by constructing a nonrecursive digital filter having a 30-Hz periodicity. This is more important when relatively noisy sources (for example, videocassette recorders) are used. "Frame combing" further reduces cross effects.

Some video engineers say that this level of performance should be improved still further by completely eliminating cross effects. This may be done by frequency or time multiplexing the luminance and chrominance information in the video signal. To eliminate cross effects by frequency multiplexing, the encoding must not let the luminance and chrominance information share the same bandwidth.

Memory Technology for Digital-Feature Television

Many new television features described in this article are made possible by low-cost digital memories used to store displayed images. The displayed portion of each of the 480 lines in the current 4:3 NTSC system takes about 53.5 μs to scan. When sampled at 13.5 MHz, this results in 720 1-byte samples per line. To facilitate signal processing, this is expanded to 720 + 180 + 180 = 1080 bytes per line; the extra samples are added so that luminance and two color-difference signals are digitally available. Widening the screen to 5⅓:3 without increasing the horizontal resolution increases this to 1080 ×5⅓/4 = 1440 bytes per line. Doubling horizontal resolution results in a total of 2880 bytes per line. Because the 657-line system has about 600 lines on the display, one HDTV image requires a total of 1,728,000 bytes of storage.

Currently there are two competing technologies for implementing this store: high-speed DRAMs (dynamic RAMs) and charge-coupled devices (CCDs). DRAMs offer the advantage of easily handling multiple-picture composition. CCDs, which operate as a FIFO (first-in/first-out) sequential store, do not require address generation. Further, the extremely high-speed requirements, 2880 bytes in 42 μs, or 1 byte about every 15 nanoseconds, may be more readily attainable in this technology. Components similar to line-addressable RAMs (LARAMs) could be developed by IC manufacturers to fill this need.

GLOSSARY

ACTIVE LINES: lines of the television signal that appear on the display; the NTSC television signal has 525 lines, of which about 480 are displayed; the remaining lines are used for synchronization and test purposes.

ARTIFACTS: visible effects, generated in a picture due to its transmission, that were not present in the original scene.

ASPECT RATIO: picture width divided by picture height; standard television has a 1.33 (or 4:3) aspect ratio; high-definition television will have a wider (perhaps 1.66 or 1.78) aspect ratio more like that of motion picture film.

CHROMINANCE: part of the television signal that characterizes the color (hue and saturation) without reference to its luminous intensity (brightness).

COMB FILTER: an electronic filter with a spectral response that consists of several equally spaced elements that resemble the teeth of a comb.

DISPLAY FACTOR: a constant that converts the number of active lines transmitted into the number of vertical lines perceived on a display.

FIELD: a sample of the lines in a TV picture (or frame); a field in NTSC TV consists of 262½ lines transmitted in 1/60 second; i.e., all the odd- or even-numbered lines in the picture.

FRAME: smallest number of fields comprising one complete television picture; in NTSC television, two fields having a total of 525 lines transmitted in 1/30 second (i.e., all the lines in a picture).

FRAME MEMORY: a digital device using either RAMs or charge-coupled devices to store a complete television picture; for NTSC television, this requires about 500,000 bytes.

INTERLACED SCAN: a means of displaying a picture whereby the lines of the second field of a frame are placed halfway vertically between the lines of the first field of a frame.

LUMINANCE: part of the television signal that characterizes the light intensity (brightness) without reference to its color (chrominance).

RESOLUTION: the number of lines that may be represented in a distance equal to the height of a display.

SEQUENTIAL SCAN: a means of displaying a picture whereby all the lines of a frame are presented one after another in sequence; sometimes referred to as progressive scan.

VIDEO FACSIMILE: transmission of one television picture from one to any other location on a CATV system in about 1 second.

If all the luminance information from 2 to 4.2 MHz is up-converted by 3 MHz, then the chrominance and luminance information are easily separable, completely eliminating cross effects.

Cross effects also may be eliminated by time multiplexing the chrominance and luminance information. Instead of encoding the chrominance and luminance information on each line into a shared-bandwidth composite-video signal, the information is individually time-compressed and shifted. For a typical MAC (multiplexed analog component) signal, sound and sync information occupies the first 10 μs (microseconds) of each line; one of the color-difference signals, time-compressed by a factor of three, occupies the next 18 μs of the line; and the luminance signal, time-compressed by a factor of three to two, occupies the remaining 36 μs of the line.

Time compression of the signal by an amount X increases the required bandwidth for transmission X times. Hence, the required bandwidth for transmission of the luminance is $1.5 \times 4.2 = 6.3$ MHz, while the required bandwidth for the chrominance is $3 \times 1.5 = 4.5$ MHz. The choice of the compression factors is based not only on bandwidth considerations but also on noise performance over the communication channel. In principle, any

(continued)

choice of $\frac{1}{X_C} + \frac{1}{X_L} = 1$ is possible; $X_C = 3$ chrominance compression and $X_L = 1.5$ luminance compression are selected to optimize subjective performance for signals having the same RGB (red-green-blue) inputs as European PAL (phase alternation line) over a direct broadcast satellite (DBS) system.

E-MAC AND THE SMART RECEIVER

Unlike current TV systems, with both the two-channel NTSC-compatible HDTV and MAC coding systems, the time position of the transmitted signal no longer directly corresponds to the position of the information on the final display. The decoder uses the memory in the receiver to change the time sequence of the signal to reassemble the picture according to a fixed predetermined mapping. S. Liong Tan (N.V. Philips) and Richard Jackson (Philips Redhill) suggested that a large number of different formats could be decoded by a "smart" receiver if the transmitted signal included format-decoding information. Recently the European Broadcasters Union modified the proposed MAC specifications to include signal format information in the last line. A "smart" receiver could select the correct picture format map from the information provided by the last line.

SUMMARY

In this glimpse into future television, I have presented the technical basis for the evolution of color television in the "information age." This is made possible by the development of frame stores using VLSI. These new components increase the extent of signal-processing capabilities that are economically viable. Local- and network-level interactive capabilities will be emphasized, including interuser transmission of digital data and video facsimile.

The exact format for HDTV and the extent of receiver flexibility are being evaluated. Once a path is cleared, the journey to future television may be completed in a few years. ■

"Despite the recent press notices, multiuser microcomputers aren't anything new!"

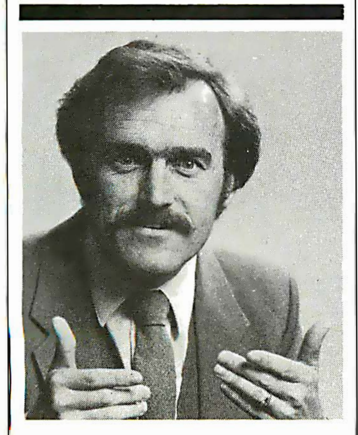
This is the first in a series of discussions with Rod Coleman, President of Stride Micro (formerly Sage Computer) on the 68000 multiuser market and its current environment.

Q: Why do you say that?

RC: "The technology to build a high performance multiuser system has been around for five years. And while some of the leaders in this industry have been pretending that micro multiuser didn't exist, we've been shipping complete systems for nearly three years. The benefits of multiuser are undeniable; it is more cost effective, and offers greater flexibility and utility. But until just recently, the marketing pressure to be compatible instead of being better, has blinded the industry."

Q: What do you mean?

RC: "Well, for example, the Motorola 68000 processor introduced 16/32-bit technology to the personal computer world a long time ago. It was fully capable of meeting high performance and multiuser design requirements in 1980. Instead of this trend taking off, most energy was spent promoting 8088/8086 products that were clearly inferior from a technical point of view. This phenomenon leads me to believe that they will soon rewrite the old proverb: 'Build a better mousetrap and the world will beat a path to your door,' but only if they can find the way through the marketing fog."



"A surprising feature is compatibility. Everybody talks about it, but nobody does anything about it."

Q: Are things changing now?

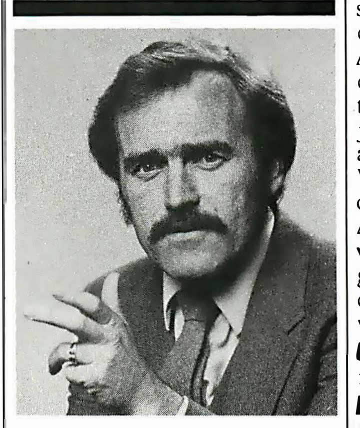
RC: "Yes and no. With the business world starting to take more and more interest in microcomputer solutions, the advantages of a solid multiuser system couldn't be kept hidden forever; companies like ours and a few others were beginning to make a dent. Instead of taking a fresh approach, some of the newest multiuser offerings will probably only give the technology an undeserved black eye! Multiuser is far more than the ability to plug in more terminals. It involves things like machine compatibility, fast processors, adequate memory, large storage capacities, backup features, networking, and operating system flexibility."

Q: Is this what makes the new Stride 400 Series different?

RC: "Exactly. That sounds self-serving, but it's true. Today a number of companies are introducing their first multiuser system. We've been building and shipping multiuser machines for almost three years. We know the pitfalls, we've fallen into some of them. But we have learned from our mistakes."

Q: Give me some examples.

RC: A hard disk is almost mandatory for any large multiuser installation. Yet, backing up a hard disk can be a nightmare if you only have floppies to work with. That's why we've added a tape backup option to all the larger Stride 400 Series machines. It's irresponsible for a manufacturer to market a multiuser system without such backup. Another good lesson was bus design. We started with one of our own designs, but learned that it's important not only to find a bus that is powerful, but also one that has good support and a strong future to serve tomorrow's needs. We think the VMEbus is the only design that meets both criteria and thus have made it a standard feature of every Stride 400 Series machine."



"The marketing pressure to be compatible instead of being better, has blinded the industry."

Q: What are some of the other unique features of the 400 Series?

RC: "A surprising feature is compatibility. Everybody talks about it, but nobody does anything about it. Our systems are completely compatible with each other from the 420 model starting at $2900, through the 440, on to the powerful 460 which tops out near $60,000. Each system can talk to the others via the standard built-in local area network. Go ahead and compare this with others in the industry. You'll find their little machines don't talk to their big ones, or that the networking and multiuser are incompatible, or that they have different processors or operating systems, and so on."

Q: When you were still known as Sage Computer, you had a reputation for performance, is that still the case with the new Stride 400 Series?

RC: "Certainly, that's our calling card: 'Performance By Design.' Our new systems are actually faster; our standard processor is a 10 MHz 68000 running with no wait states. That gives us a 25% increase over the Sage models. And, we have a 12 MHz processor as an option. Let me add that speed isn't the only way to judge performance. I think it is also measured in our flexibility. We support a dozen different operating systems, not just one. And our systems service a wide variety of applications from the garage software developer to the corporate consumer running high volume business applications."

Q: Isn't that the same thing all manufacturers say in their ads?

RC: "Sure it is. But to use another over used-term, 'shop around'. We like to think of our systems as 'full service 68000 supermicrocomputers.' Take a look at everyone else's literature and then compare. When you examine cost, performance, flexibility, and utility, we don't think there's anyone else in the race. Maybe that's why we've shipped and installed more multiuser 68000 systems than anyone else."



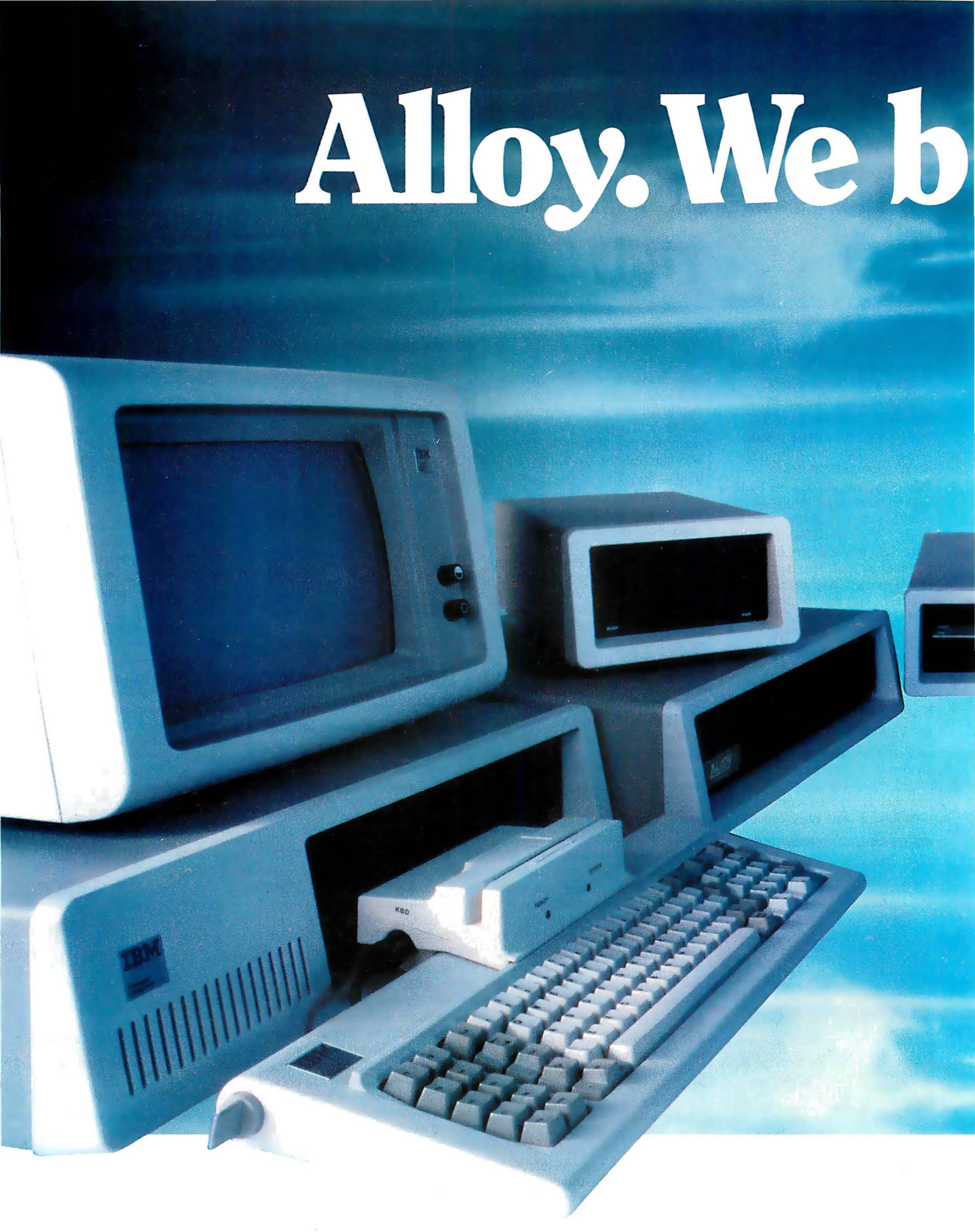


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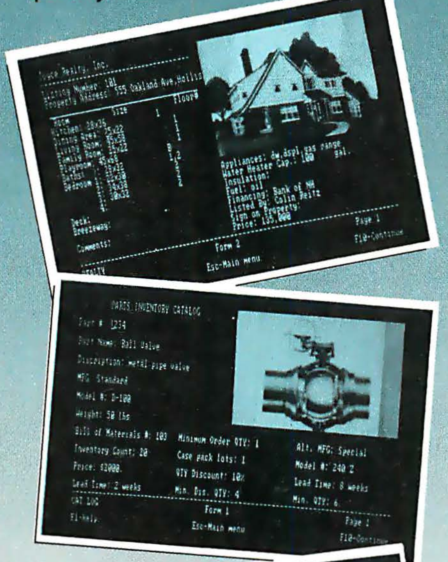
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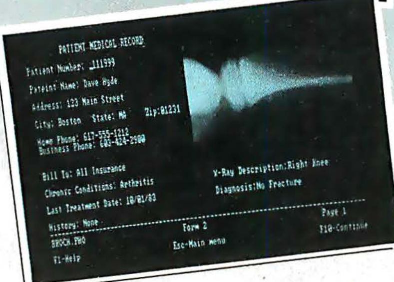
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BY GREGG WILLIAMS

MICROSOFT MACINTOSH BASIC VERSION 2.0

More Mac support and true parameter-passing subprograms

Author's note: This article describes the features of the new version of Microsoft BASIC *for the Apple Macintosh, available for $150. Because it is based on a prerelease copy of the software involved, this article does not include any evaluation of the software's performance. Since the software's functionality had been "frozen" (i.e., no new features were to be added to the product), this article should be an accurate description of the software's content and structure. A full software review will follow sometime in the future.*

Microsoft Corporation released a version of its BASIC for the Apple Macintosh computer shortly after the machine's release. Although this version used few of the Macintosh's special features (windows, pull-down menus, etc.), it became popular, largely because it was the only BASIC available. (Apple's Macintosh BASIC, as of this writing, was still not available.)

Microsoft recently introduced Microsoft BASIC version 2.0 (I'll abbreviate Microsoft BASIC for the Apple Macintosh as MBASIC 2.0 to contrast it with Apple's product, called Macintosh BASIC). Because most people are familiar with the generic Microsoft BASIC (which is similar to MBASIC version 1.0 for the Macintosh), I'll limit this description to those features that are new. MBASIC 2.0 is upward-compatible with programs and data files created using MBASIC 1.0. Figure 1 shows the List (program listing) window for an MBASIC 2.0 program and the contents of the Windows menu.

WINDOWS

The WINDOW statement lets you create and close (eliminate) windows, direct program output to one of several windows, and get information about a certain window (for example, its size or the position of the cursor in the active window). The number of windows in your program is limited only by the amount and usage of the Macintosh's memory.

In addition, the PICTURE ON statement causes a variable called PICTURE$ to accumulate, according to the manual, "a set of encoded Macintosh instructions which, together, produce a screen image." The

(continued)

Gregg Williams is a senior technical editor for BYTE. *He can be contacted at* POB 372, *Hancock,* NH 03449.

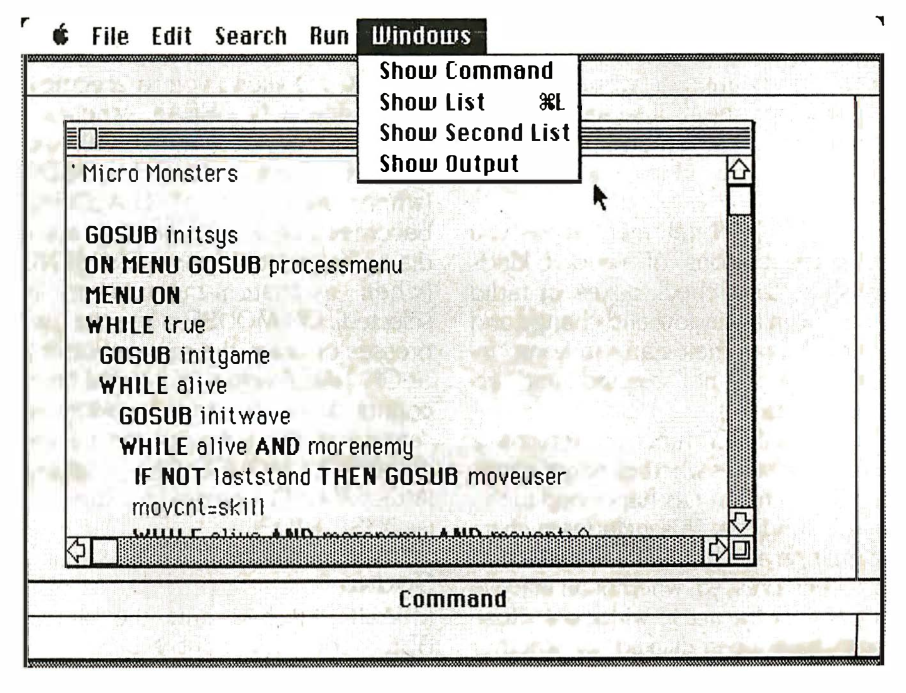


Figure 1: *Microsoft Macintosh* BASIC 2.0. *Note the lack of line numbers in the program and the selections in the new Windows menu.*

MBASIC 2.0 comes in two versions that use different floating-point-number formats but are otherwise identical.

programmer can use the stored value of this string to reproduce the contents of a window. With some additional programming, you can use this statement to create a program that redraws the contents of an output window when an obscuring window is removed. (MBASIC 2.0 automatically redraws List windows but not output windows.)

EDIT FIELDS, BUTTONS, AND DIALOG FUNCTIONS

The EDIT FIELD statement allows you to specify any rectangular area of an output window as an edit field. This lets the user of your program edit the contents of that field (which can be blank or contain a string of your choice) with the mouse and the edit functions (cut, copy, and paste)—just as you would be able to do with, say, MacWrite.

The BUTTON statement allows you to place buttons of various kinds (push buttons, check boxes, or radio buttons) in a window and change and inquire about their status (among "inactive," "active, not selected," and "active, selected").

The DIALOG function returns a value that states whether or not something significant has happened in the active windows. This includes such information as whether or not a button has been pressed, whether an inactive window or the active window's "close box" have been clicked, or whether a window needs to be refreshed.

With the above statements and the WINDOW statement, you can create windows that refresh their contents when needed and windows that look and behave like standard Macintosh alert and dialog boxes.

MENU BARS

The MENU statement lets you create up to 10 custom menus, each with up to 20 items; menu items can be inactive, selected, or selected and marked with a check box. MBASIC 2.0 makes no provision for a Command-key sequence to substitute for a menu item (like, for example, Command-C to substitute for the menu item "Cut"). The MENU function returns the values of the menu and item numbers of the last menu selection made.

EVENT TRAPPING

The numerous event-trapping statements let you control your program via various events without tedious programming—things like mouse clicks, button and menu selections, and window activations. These functions are the "glue" that will usually hold together a BASIC program that makes heavy use of the Macintosh user interface.

In addition to the ON ERROR GOSUB *nnnn* from MBASIC 1.0, which executes the subroutine at line *nnnn* when the program detects an error, MBASIC 2.0 allows you to execute a subroutine: ON BREAK (whenever Command-period, the break sequence, is pressed), ON DIALOG (when the value of DIALOG(0) becomes nonzero, indicating some dialog-box-related event), ON MENU (when a custom-menu item is selected), ON MOUSE (when the user presses or drags the mouse button), or ON TIMER (when an internal timer counts down to zero). In addition, sensing of these events can be enabled (e.g., MOUSE ON), disabled (MOUSE OFF), or stored for later use (MOUSE STOP).

SOUND

MBASIC 1.0 had only the simple BEEP command, but MBASIC 2.0 adds a SOUND command that lets you control the tone and length of up to four sound generators. In addition, sound commands (to an unspecified limit) can be queued up with the SOUND WAIT command, then released with SOUND RESUME; this allows you, for example, to set up and then play several sound generators in synchronization.

Another statement, WAVE, lets you use waveforms other than the default (a square wave). The parameter SIN specifies a sine wave; 256 elements from a selected integer array specifies any other arbitrary waveform. While the use of a single square-wave sound generator may slow program execution about 2 percent, the use of multiple arbitrary waveforms can cut execution speed by more than 50 percent.

TWO VERSIONS

Microsoft has made the unprecedented move of supplying *two* versions of MBASIC 2.0, which use different floating-point-number formats but are otherwise identical. The BCD (binary-coded decimal) version is better for business and financial programming because it eliminates the rounding errors that sometimes occur when using binary floating-point arithmetic (the kind used by most BASICs). This version is compatible with programs and data files created by MBASIC 1.0 and defaults to double precision for numeric values. The binary version of MBASIC 2.0 (which adheres to the IEEE floating-point-number standard) is faster than the BCD version because it defaults to single precision for numeric values and for the calculation of transcendental functions. The binary MBASIC 2.0 icon and BASIC program icons show a small flowchart and a pi symbol. (The decimal-version icons look like their counterparts that are found in MBASIC 1.0.)

EDITING AND DEBUGGING

MBASIC 2.0 adds a number of much-needed editing and debugging features. Find and find-and-replace menu selections automate the tedious process of looking through a program listing for things that need to be changed. A find-the-cursor menu

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selection allows you to scroll through your program and return to your original location without the trial and error that you previously had to do. You can also do full Macintosh-style editing in the List window; this is a great improvement over MBASIC 1.0, which forces you to copy a BASIC line to the command window for editing.

Another improvement is that MBASIC 2.0 allows you to make only two List windows. In MBASIC 1.0 you can have three List windows open, which wastes memory.

MBASIC 2.0 adds a single-step capability to the TRON and TROFF statements available in MBASIC 1.0. Single-stepping, which is invoked using the Step selection under the Run menu (or by pressing Command-T), causes MBASIC 2.0 to execute one statement and highlight it in the List window (if it is visible). Note that only one statement is executed; if a line contains multiple statements, only the current one is highlighted.

NEW LANGUAGE FEATURES

The Macintosh-environment enhancements to MBASIC 2.0 are certainly exciting, but Microsoft has made improvements to the BASIC language itself that are actually more important. None of these features are new to BASIC itself, but their inclusion in a Microsoft BASIC tends to ensure their inclusion in future Microsoft BASICs, which will probably set a de facto standard for the microcomputer community. The new features, which include program-format changes and subprograms that pass parameter values, rectify most of the shortcomings that programmers have against the language and make it a serious competitor to Pascal for many users.

The criticism of BASIC as an unreadable, monolithic language is largely due to its lack of formatting (indenting lines to clarify, for example, the body of a DO loop) and its requirement of line numbers. MBASIC 2.0 programs are stored as they are typed in—this includes any cosmetic use of spaces, even blank lines. MBASIC 2.0 requires line numbers—or, equivalently, alphanumeric labels delimited by colons—only when needed to specify the destination of GOTOs, GOSUBs, or IF-statement branches. MBASIC 2.0 also converts BASIC keywords (which may be entered in lowercase) to uppercase and boldface in the List window.

The subprogram (delimited by SUB and END SUB statements) differs from the subroutine in that the former can pass values from the calling statement to the subprogram definition; this feature greatly increases the power of the language and is a part of most sophisticated programming languages (FORTRAN, Pascal, and Modula-2, among others). The vari-

(continued)

ables used in the SUB statement are called *formal* (or *dummy*) *parameters* because they are not actual variables that can conflict with variables of the same name elsewhere in the program—they are placeholders for the values that are passed to the subprogram when it is called.

MBASIC 2.0 subprograms support call-by-reference and call-by-value parameter passing (in the latter, the subprogram *cannot* change the value of the variable used as a parameter in the calling statement). Simple variables in the calling statement are called by reference (meaning their values *can* be changed) unless they are surrounded by parentheses, in which case they are called by value. Calling statements can pass array names as parameters, and the size of the array does *not* have to be declared in the definition of the subprogram.

In addition to its formal parameters, which are *local* to the subroutine (meaning their values do not exist outside the subprogram), the SUB statement can include a list of shared variables, variables that are *global* (meaning they have the same value both inside and outside the subprogram). The SUB statement can also declare that all the variables inside it are *static;* the variables retain their values from one invocation of the subprogram to the next.

Subprogram definitions cannot contain other subprogram definitions. This means that variables cannot have varying degrees of locality (as they can in Pascal, for example). However, you can limit the scope of some variables by defining them as shared with some subprograms but not others.

A subprogram can be called either by its own name or with the CALL statement (which is also used to call machine-language subroutines). For example, if a subprogram is defined with

```
SUB POLY_AREA
   (SIDES,LENGTH,RESULT)
```

it can be called as

```
CALL POLY_AREA(5,12,area)
```

or as

```
POLY_AREA 5,12,area
```

(note the lack of parentheses in the latter case).

DOCUMENTATION

The MBASIC 1.0 reference manual has 215 pages; the MBASIC 2.0 manual has 378 pages, which includes examples of almost every feature described. For example, the "Access to Macintosh ROM Routines" appendix is five pages in the first manual and eleven pages in the second (which documents the same number of routines, only in greater detail). The MBASIC 2.0 documentation spells out

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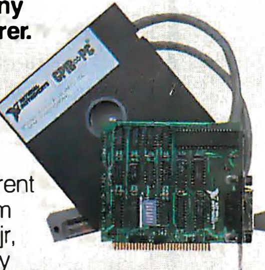
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MBASIC 2.0

the language's functions more completely, which allows most of us to more fully use the language without having to be wizards that understand the inner workings of the Macintosh.

MISCELLANEOUS FEATURES

MBASIC 2.0 contains too many other improvements to mention here, but some notable ones follow.

You can now load in BASIC files using the "Open..." menu selection (which gives you the scrolling window display known as the Mini-Finder). Because the Mini-Finder has a "Disk" button, you can load (without knowing the names of) files from your system's alternate disk drive.

MBASIC 2.0 allows you to cut and paste pictures between it and an external application (MacPaint, for example). This allows you to draw a picture using MacPaint, then manipulate it within an MBASIC 2.0 program.

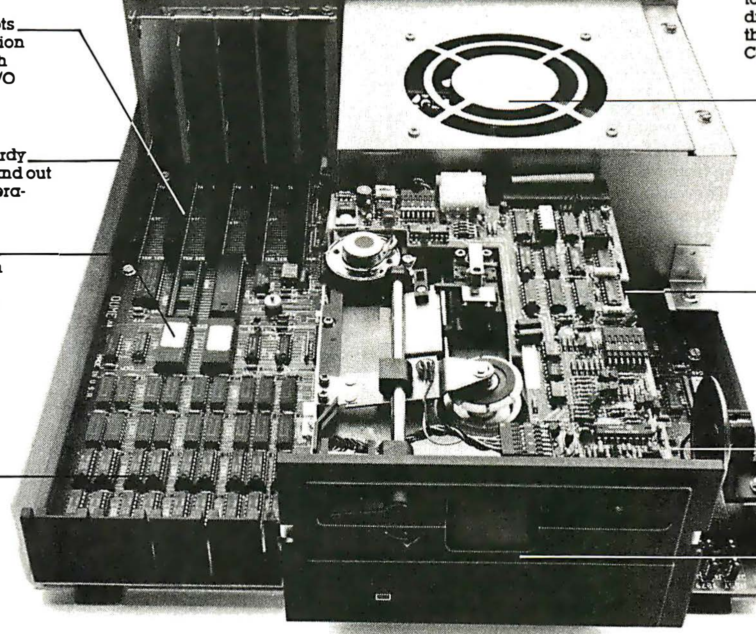
You must interrupt a running MBASIC 2.0 program with the Command-period keystroke instead of Command-C. This makes MBASIC 2.0 consistent with other Macintosh applications and frees the Command key to be used (as in a terminal-emulation program) as a control key.

The FILE$ function allows a program to prompt the user for a filename using either a fill-in-the-blank dialog box (as is used by MBASIC 1.0 itself to get a filename) or the Mini-Finder dialog box mentioned above. Both forms let you specify an optional prompt string, which allows you to use this statement to get something other than a filename.

CLOSING REMARKS

This product description makes no attempt to evaluate the performance of MBASIC 2.0. By the time you read this, Microsoft BASIC for the Apple Macintosh version 2.0 (called MBASIC 2.0 in this article) and Apple Computer's own Macintosh BASIC should be available. We will compare the published versions of both BASICs as soon as they are available. In any case, MBASIC 2.0 is a considerable improvement over its predecessor, Microsoft Macintosh BASIC 1.0. ■

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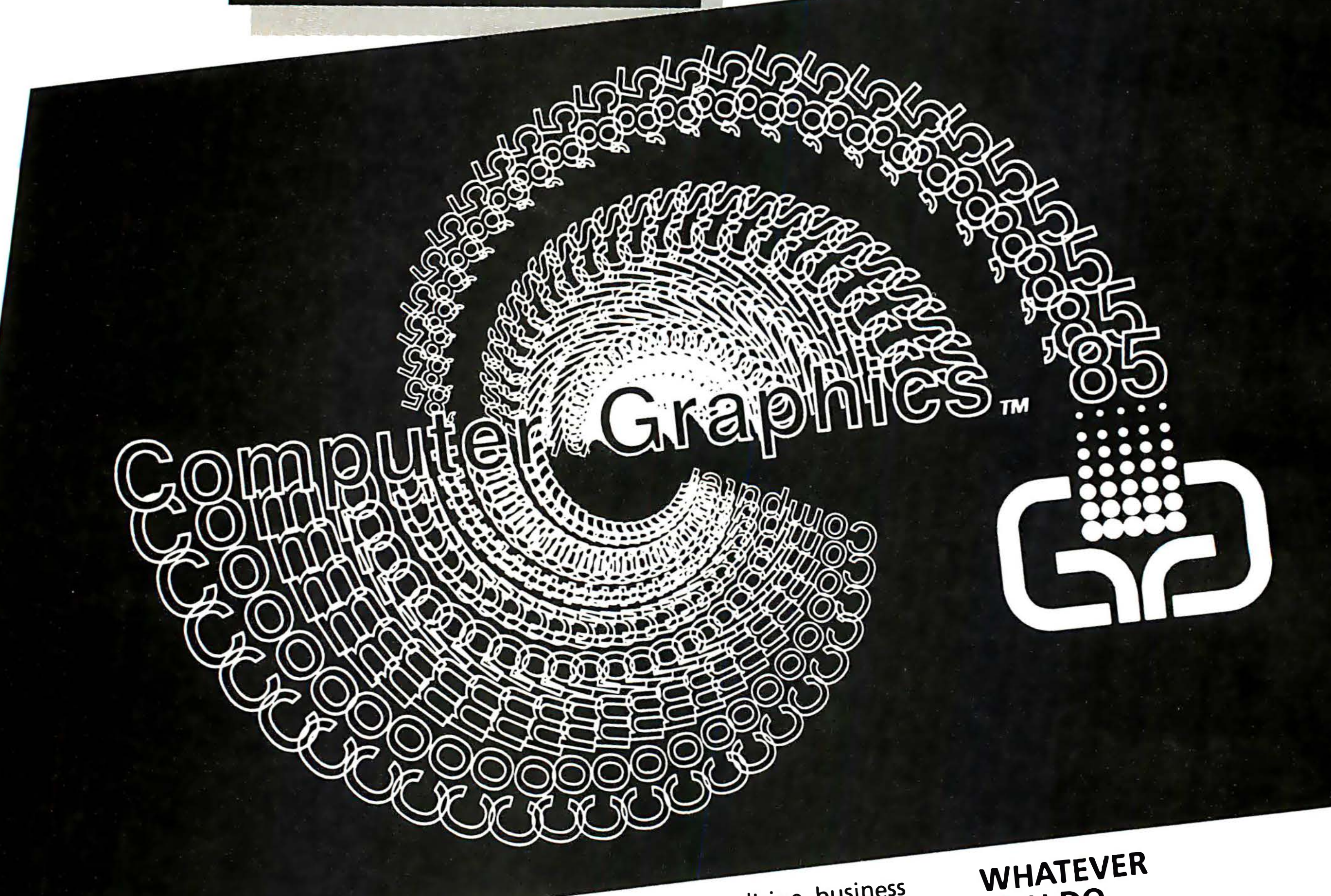
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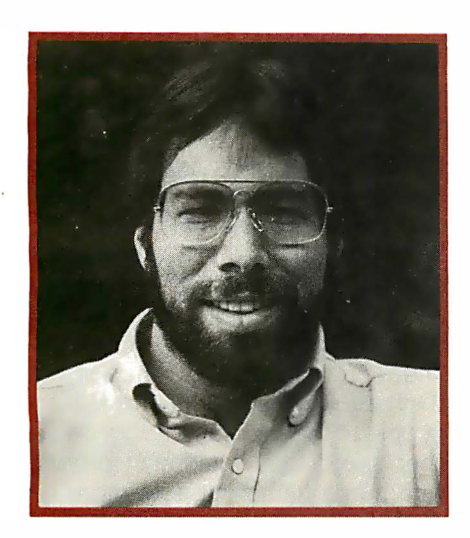
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THE APPLE STORY

PART 2: MORE HISTORY AND THE APPLE III



An interview with Steve Wozniak

Last month, Steve talked about his background, the evolution of the Apple I and II, and the early days of the company. In this part, the conversation switches to various aspects of the Apple II design, later personal history, and Steve's thoughts about the personal computing industry.

SWEET-16

BYTE: *One of the more interesting things in the Apple II ROM was your 16-bit pseudomachine called "Sweet-16." How did you come up with that?*

WOZNIAK: While I was writing my BASIC, I had been thinking about ways to save code. There were several places where I had to handle 16-bit pointers with an 8-bit processor, and that was pretty awkward.

So I decided to write a little emulator and implement a 16-bit machine that could interpret pseudocodes and implement registers 0 to 15 in the 6502 base page. It ran about 30 times as slow as 6502 assembly language, but it saved tons of code every time I used it in a program.

BYTE: *Did you actually use it in your Integer BASIC?*

WOZNIAK: No, I never had the time to reimplement the BASIC to use it. But I did use it in later years to write things like BASIC renumbering routines totally in Sweet-16. It was easy to mix Sweet-16 code with assembly language.

BYTE: *Isn't Sweet-16 still used in Apple DOS and ProDOS editor/assemblers?*

WOZNIAK: Yes, it's used in EDASM [the Apple Tool Kit 6502 editor/assembler], mostly in the editor portion. Randy Wigginton wrote EDASM. He's worked here since before we even had a company. Lately he's written the Macintosh word processor—MacWrite. He's done a lot for the company, and he's used Sweet-16 in several things he's done.

THE DISK DRIVE

BYTE: *Can you tell us a little about how you came up with the Apple II disk drive and how you ended up picking your form of group-coded recording?*

WOZNIAK: The disk design was my most incredible experience at Apple and the finest job I did. I never really knew what a disk controller was or what it had to do. But at Hewlett-Packard I had looked through a Shugart manual to see what signals were used and what they did. There were signals to make the head step in and out and signals to cause magnetic flux changes. It was similar to audio recording, and I knew about that. It was like a signal on a tape where you write it and then you read it back. So I figured out a simple little circuit to write signals at changing rates and read them back. I didn't know how disk controllers worked, so I assumed that I was doing something totally different. Maybe it wasn't as efficient, but at least I could write some data and read it back.

Well, Mike Markkula was annoyed because the cassette tape was too slow. He had a favorite checkbook program, and it took two minutes to read in the program and another two

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PHOTOGRAPH COURTESY OF APPLE COMPUTER INC.

'Hobbyists are a tiny part of our market, but they're faithful to the company.'

minutes to read in his check files. He was complaining about this at a staff meeting, and I mentioned that I had this clever little five-chip circuit that could read and write a floppy disk. At the time, all the existing floppy-disk controllers were 40 or 50 chips, so I knew there must be something important that I wasn't doing.

I went off and tried to figure out what it was that I wasn't doing. One of our technicians had a North Star system, so I looked through their manuals. I read their schematics and figured out what every chip did. And I looked through their listings until I understood exactly what they were doing.

I was doing a lot more. I didn't even have to look at the sector holes, so I could use any disk drive, any floppy disk in the world. It was then that I new I had a really clever design.

The next week was Christmas vacation. Randy Wigginton and I spent the entire week, including the holidays, trying to get this disk reading and writing with a very simple operating system. We did the bottom levels of an operating system in that week. You could type R (for "read") followed by a program name like STARTREK, and it would load STARTREK into memory.

We were highly motivated because, at the end of the week, a show called the CES [Consumer Electronics Show] was starting in Las Vegas, and we wanted to go.

We worked all night the day before we had to show it [the disk drive] at CES. At about six in the morning it was ready to demonstrate. Randy thought we ought to back it up, so we copied the disk, track by track. When we were all done, he looked down at them in his hands and said, "Oh, no! I wrote on the wrong one!" We managed to recover it and actually demonstrated it at CES.

BYTE: *Had you been exposed to group-code recording before, or did you invent yours independently?*

WOZNIAK: The first version of the floppy-disk routines did not have group coding. I had followed the Shugart manual, which showed that you had alternate clock bits and data bits, so every other bit was wasted. I couldn't understand why it was necessary, but I started that way.

Then I came up with this idea to use coded recording. I knew the technical rule was that you could only have one or two zeros in a row. You could have either 4 or 8 microseconds between flux transitions. I didn't really know what group-coded recording was; I just knew that I could fit 13 sectors on a disk instead of 10. I had to write a program to take bytes off the disk, convert them to 5-bit chunks, and reassemble them into 8-bit data bytes.

It was a difficult routine to write. It was about a 20-hour job, and I'd work through the day for 10 or 12 hours and I wouldn't quite get there. The next day I'd come back and find out that I was starting exactly where I had the day before. This went on for almost a month. I was not quite getting the routines, and we were getting within a month of shipping the disk drives. Finally I stayed up all night until I got all five routines that had to work together done. So we were able to ship it the first time with the group-coded recording in place. Later, we changed the encoding method and stepped up to 16 sectors. That was DOS 3.3.

BYTE: *The Macintosh uses a custom chip called the IWM—Integrated Woz Machine—that does the same sort of recording. Can you tell us anything about that?*

WOZNIAK: My design was basically a little sequencer, or state machine. It used a PROM and a latch and cycled through various states depending on the input data coming off the floppy disk. The IWM takes that design and adds other features like the ability to go twice as fast—it can also do IBM format, double-density recordings.

BYTE: *It sounds like a fascinating part. Do you think we'll see Apple II owners benefit from it in any way?*

WOZNIAK: Well, it's our standard disk controller now, and it's cheaper than the older design. It's used in the Apple IIc.

BYTE: *Could you use it to get higher-density recording on an Apple II 5¼-inch disk?*

WOZNIAK: No, because the disk drives themselves aren't certified for double-density recording. You need heads with the proper gap, and they're more expensive.

BYTE: *You're a former hobbyist. Could a hobbyist buy one of these chips and a spec sheet and start playing with it?*

WOZNIAK: I don't think Apple would give out the spec sheet. I totally disagree with that policy because I'm very respectful to the hobbyists. They're a tiny part of our market, but they're loyal supporters and faithful people to the company. If they had a spec sheet, they could start playing with it and figure out a lot more incredible things that we never planned it to be used for—even using it as a communications channel from Apple to Apple, Macintosh to Macintosh. There are a lot of great tricks you could do with that little part. It's a beautiful random I/O device that has too many things that have not been taken anywhere.

Personal Details

BYTE: *In 1981 you were in a plane crash and you left Apple for a while shortly after that. How long did it take you to recover from the accident?*

WOZNIAK: That was in February 1981. For about five weeks I had a type of amnesia that prevents you from forming any new long-term memories. After I recovered, people would show me pictures of myself in the hospital, playing games with my computer with my face all battered up. They would tell me stories of how I tried to sneak out of the hospital to visit my wife, Candy, or how I went to parties and rode my motorcycle. I didn't remem-

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ber any of that. I had all of my old memories, but I'd forget new things from one day to the next. Finally I came out of it one night, but I never got those memories back.

BYTE: *Why did you leave Apple?*
WOZNIAK: We had a hundred engineers at that point, and I was no longer really important to the company. I didn't want to be a manager; I was just an engineer, and I wasn't really needed there. But I didn't feel comfortable going to Steve Jobs or Mike Markkula and saying I wanted to take off. The plane crash was a good excuse. After five weeks of amnesia, I simply didn't go back. I decided that if I was going to take a year off I might as well finish college. It was the hardest year of my life.

BYTE: *We've heard that you went to UC–Berkeley and had some run-ins with your instructors. Could you tell us about that?*
WOZNIAK: I was going under an assumed name—Rocky Clark—so they didn't know who I was. I took computer science courses, economics, statistics, and a few other courses.

My computer science courses were interesting, but I have to criticize them a little because they taught only specific problems with specific solutions. You spent your time memorizing standard problems and solutions and then tried to recognize variations of them in the tests. You weren't supposed to explore new avenues or try things that nobody else was doing. You were only supposed to learn the proper answer. They thought that you could be trained to know all the problems and the standard solutions. Once you learned them all, you could solve them. It was wrong because they weren't really teaching you to solve problems—they taught you to identify them.

My economics course was interesting also. We had a socialist TA [teaching assistant] who taught us that companies made money by cheating the consumer. All the kids in the class thought that companies would make a lot of profit if they could figure out a way to cut the costs of a product down, to make it cheap and screw the consumer.

I contrast that with the way we did things at Apple. Every product design decision was based on what consumers wanted, what would compete the best, what they would buy. We tried to do what customers wanted, in our best judgment, and give them high-quality products.

So I would stand up in class and argue about what the TA was saying. After a while he started telling me to shut up, or that he would kick me out if I interrupted him again. Apple was the greatest business success in history, but I couldn't tell him who I was.

BYTE: *So you came back to Apple after about a year. What would you say is the most important thing that you've worked on since you came back?*
WOZNIAK: There isn't too much. When I came back I started getting a little bit involved with this division's management, but it was unofficial. Officially I took the title of Engineer. Mostly, I've stayed involved with the Apple II because that's where I've got the most to offer.

Because I'm a founder at Apple, I could take almost any role I want, but I've tried to avoid the newest, most far-reaching projects because there are other capable people to do them. I try to stick to small projects where I can sit down and handle them myself.

CURRENT WORK

BYTE: *Do you have anything interesting going on now?*
WOZNIAK: There are not many individual projects in this whole business. The floppy disk may have been the last one for Apple. I have got a few projects that I'm working on now, but they're not all going at once.

WOZNIAK INTERVIEW

The language Fifth is one of them, but I haven't written it yet. I'd like to combine the best features of BASIC, FORTH, and Pascal, and leave out the worst ones. You could have the formal structures of Pascal, the immediateness of BASIC, and the extensibility of FORTH. In FORTH or Logo, new words become part of the language, and you can use them immediately. It's really helpful for debugging. In Macintosh Pascal, you can define a procedure and run it immediately. I also want some level of globalness, like BASIC. I don't want to always have to declare a variable before I can use it. I like variables with scope, but I'd like undeclared variables to be totally global.

Another project is an operating system, like the one on the Macintosh, only a bit different and a lot more relational.

I also have a hardware project that I'd like to do, a personal computer based around consumer video sources like TVs, videotapes, and videodiscs. It would switch them around, synchronize them, and mix them, sort of like a little home editing studio. I think it's possible because memories are getting so cheap. You could hold a frame from each of your video sources in memory and let the software accommodate the sync variations. There are a lot of new chips available that do NTSC modulation and demodulation, so there ought to be a minimal chip solution.

My main interest is still the Apple II—the home computer we started with. I'd like to see Apple do more with speech. There are some really inexpensive speech chips now, and that's the way the rest of the personal computer world is heading. I think we've been deficient in that area.

SPECULATIONS

BYTE: *Are you thinking about using the new 65816 processor for anything?*

WOZNIAK: We're thinking about it and doing some R&D with it, but I don't know if we'll use it. Anything we do has to be compatible with the Apple II. If we found out that the 65816

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THE SPREADSHEET

In late 1982, A.P.P.L.E., a national Apple users group, offered an astounding value to its members. For $22.50, A.P.P.L.E. members could purchase a fully functional VisiCalc-like spreadsheet program called "THE Spreadsheet." At the time, various versions of VisiCalc and other popular spreadsheet programs were selling for between $200 and $300. THE Spreadsheet offered most of the features found in VisiCalc and added a few of its own. What's more, it was coauthored by the now legendary Steve Wozniak. Mysteriously, THE Spreadsheet was available for only one month, after which it was permanently discontinued. Since that time, original copies of THE Spreadsheet have become one of the few legitimate microcomputer collector's items. In the following segment, Steve describes how THE Spreadsheet came about.

WOZNIAK: It started because Mike Scott was having difficulty negotiating with Personal Software [now VisiCorp] about VisiCalc. They just wouldn't do what he felt was right as far as giving Apple breaks on price or doing new enhancements to it. So he came by one day and he said to me, "Would you like to do a VisiCalc?" It wasn't even known as a spreadsheet then.

I was really scared. VisiCalc was the only spreadsheet for a long while, and none of us had really been in business before. Was it legitimate to go out and do your own spreadsheet? Or was it equivalent to just copying and ripping somebody off? I didn't want to get close to this whole thing because I didn't want it to look like I was copying somebody else.

Mike got Randy Wigginton and Randy said, "Sure, I'll do it." I said I'd do the arithmetic routines because they were general—something that could be used by any program—and I had some good algorithms that I had picked up at Hewlett-Packard that I wanted to implement.

So we started working on it and, a little ways in, Randy finished it. He wrote 4K of code in a couple of weeks, and I was shocked that he came in so quick; I hadn't even started mine. So, I was getting to work on my arithmetic routines and my first demo was almost ready but still a few days off.

At the time, everyone was trying to get the Apple III into production. Mike Scott was camped out in the Apple III building, forcing the things that had to get done to get it finished and delivered on schedule.

He was in a bad mood. Everywhere anyone ran into him in the company, he had a sour face—no laughs, no jokes. And because Randy finished his first part of the spreadsheet and I hadn't finished my first part, he'd always come to me. The way he was talking to me, I was afraid I was going to get fired. He was in a *bad* mood.

It was the scariest time of my life at Apple. I was really getting badly addressed just for not being on time with something. I had three more days to go, and I didn't dare run into him once more because I was already way overdue. So I said, "I've got to get him in a good mood for three days."

Well, he's a Star Wars fan. He gets the T-shirts the cast gets before they get them because he knows who prints them. So I had a friend of mine call his secretary saying, "This is George Lucas. Is Mike Scott in?" Of course he wouldn't leave a phone number, but he said, "I'll call back." It actually worked. Mike was in a good mood for a few days, and I got my routines done.

Anyway, we finished the spreadsheet, and Apple started looking it over. Originally it had been defined to be as accurate as VisiCalc, and we were so much faster than VisiCalc it was ridiculous. The exponential routines that I really wanted to write for so long, because I had a good algorithm, were 30 times faster than VisiCalc's.

All of a sudden we started hiring experts on precision and things like that, and they started redefining the project from what Mike Scott had originally defined. They added a lot of features that Randy had to implement. This made life very difficult here at Apple, so we finally decided, "No, it won't be a Special Delivery Software product [a line of software offered by Apple a few years ago]."

After a long, long time, Randy went to *Call-A.P.P.L.E.* [the magazine put out by A.P.P.L.E.]. One night we were out to dinner and he said to Steve, "Well, I'm going to sell that to *Call-A.P.P.L.E.*" or "I'm going to give this spreadsheet to *Call-A.P.P.L.E.*" Steve said, "Well, that's good" or something like that. It was not official or formal. Randy went ahead and hit on it and gave it to *Call-A.P.P.L.E.* It was sold for $22.50—really cheap. We didn't want any money out of it. It was just the old Homebrew Computer club spirit of "Give to help others."

It was a good product, and it had been delayed well over a year. If Apple didn't want it, they should have just gotten rid of it, and it would have been out a year sooner. As soon as it popped up from *Call-A.P.P.L.E.* and was advertised, Apple got in a real huff about it. They forced *Call-A.P.P.L.E.* to only sell it to members, and only one copy per member. So Apple basically put it out of business—only allowed it to be sold for one more month.

It's really funny, because how did Apple get started? I designed the Apple while I was at Hewlett-Packard. Hewlett-Packard has a policy of deciding about these things very quickly. They would check with their legal department and other divisions and decide very quickly. So they gave me a formal release on it quickly because they didn't want it. But here was Apple, which didn't want it but wasn't going to release it.

If you use much Apple II software, you'll be surprised when you take the spreadsheet that Randy and I wrote and boot it in. It boots in so fast, you can't believe what's going on.

BYTE: *Is that because there's no copy-protection on it?*

WOZNIAK: No. Believe it or not, I used those routines that I did for Apple II Pascal.

BYTE: *You, Randy Wigginton, and Guil Banks were listed as the authors. Who is Guil Banks?*

WOZNIAK: Guil is right here in this building. I did the boot stuff, and he had written a lot of the other fast disk routines in there. He did all the routines that managed the disk and read and wrote DOS files appropriately without using DOS.

This was basically an all-volunteer project that we did all on our own time. And it was really neat, so we decided that we'd give it to the rest of the world.

wasn't, it would be a serious question. It's too new a part right now.

BYTE: *How is its performance compared to the 68000?*

WOZNIAK: It should be available soon in an 8-MHz version that will beat the pants off a 68000 in most applications, and in graphics applications it comes pretty close. Some of the Macintosh people might disagree with me, but there are ways around most of the problems they see. An 8-MHz 65816 is about equivalent to a 16-MHz 68000 in speed, and a 16-MHz 68000 doesn't exist.

BYTE: *The Apple II family has been a great success, and many innovations have come along to extend its life. What things do you think were responsible for its success?*

WOZNIAK: For three years we were one of the biggest business successes in history. We had three years of fantastic business success, and lately we've had three years of sort of dismal business. We've grown, but any additional revenues have just replaced the stock dilution, and the price remains about the same.

During that three years there were two main factors that led to our success—our floppy disk and VisiCalc. Out of the original home computers, which included the TRS-80 and the Commodore PET, ours was the only one that had enough memory to run VisiCalc. VisiCalc and the floppy disk sent this company into the number-one position.

We were also very faithful to our users—we tried to support everybody. When we changed over to floppy disks, we still supported cassettes heavily. When we moved up to the Apple II+ with floating-point BASIC built in, we still supported the original Apple II.

Lately our strategies seem to be changing. When we come up with a new enhancement, we start moving away from the prior version much more quickly. This could be harmful to our good relationships with a lot of our faithful users.

The Apple IIe is a good example. Most new software that really uses the features of the Apple IIe won't run properly on an Apple II or II+. A lot of good software for the Apple II+ won't run on the Apple IIe. It's an incompatible world.

BYTE: *How do you think the Apple II family will be extended and improved in the future?*

WOZNIAK: There are obvious areas. We're always trying to come up with better combinations of features and still reduce the cost. We're looking into improved processors like the 65816 we discussed before. Video resolution is always improving. We're trying to increase speed and the amount of memory in the machine because it's critical to certain applications.

The IBM PC is very successful, and it had no competition from Apple for the last three years because we made sure that it didn't. We would not allow the Apple II to compete in that market for three years.

PCSD is the most difficult division in the company. [Steve is referring to the Personal Computer Systems Division, responsible for the Apple II and Apple III products.] We're hamstrung by the need to be compatible; Macintosh isn't.

So we will continue to make improvements and produce new machines, but they'll always be compatible. With the Apple IIe we went to 128K, 80-column display, and double-resolution graphics. We came out with the IIc portable.

Apple versus IBM

BYTE: *What did you mean when you said that the Apple II was not allowed to compete in the IBM market?*

WOZNIAK: Apple has never really supported the Apple II in the business market. If you walk around a trade show and look at the software running on the IBM PC, you'll see that most of it is a step above what's possible on today's Apple II. They have more RAM that's easily addressed and better access to hard-disk drives. Programs like 1-2-3 cannot be easily implemented on a 128K Apple II, but IBM has a capable machine for that level of software. Our machine has to be able to address more memory and

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> 'I have positive and negative feelings about things Apple has done.'

handle larger disk drives before we can really start to compete with equivalent software because IBM beats us in capability today. We need better screen resolution, more memory, and better speed. A 16-bit processor would help, although "16-bit" really doesn't mean that much.

Whatever we do will be compatible, because we don't want to alienate our existing customer base. If we can come up with the right machine, then we can start to talk about some really good software and compete well with IBM. Even if we do, the new features won't really be used right away.

BYTE: *Have you said all that you meant to say about where Apple is vis-à-vis IBM and where you personally feel that Apple has made its mistakes?*

WOZNIAK: I have both positive and negative feelings about things Apple has done, but I'm always honest. There is one real mistake that Apple made, in my opinion, and this is very subjective. It is symbolic of what could happen to IBM with its PCjr.

We had become a huge business success in 1979. We had really made it with our floppy disks and VisiCalc, and it looked like we were going a long way. So we decided it was time to start putting together a real company, a big company. We needed to start staffing up and hire a lot more engineers. So we set the Apple III project in motion.

The executive staff felt it understood the Apple II market. After VisiCalc, it was perceived that 90 percent of all Apple IIs sold were going to small businesses. Only 10 percent were going into this home hobby market that we originally thought was going to grow to be billions. Originally we were a home hobby computer. Now, suddenly, small businesses were buying Apple IIs, and they wanted more features—an 80-column display, lowercase characters, maybe more graphics modes and colors, and more memory. These were all the things that one product, VisiCalc, led to.

According to any research we could dig up, many people were buying the Apple II for small business because it had a disk drive and it could run VisiCalc. These weren't the people I was closest to, so I kept my mouth shut because I was only one out of the staff of 15. So we started staffing

(continued)

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up and building an organization and a management structure based around doing this new product—the Apple III.

THE APPLE III

We had some problems getting things done on time with the Apple III because of (a) our lack of experience as a group working together, and (b) not being able to predict project lengths well enough.

We started hiring intermediate levels of managers. Sometimes the managers were getting hired at a rate that added a completion date to the project faster than it was getting completed.

Around this time we started developing a perception of market separations—good strong separations between products so they don't overlap. You don't want to design a product that competes heavily with your own existing product. I claim that's untrue. What you really don't want to do is design a product that doesn't offer any more than your existing product.

So we started setting up strong boundaries. The Apple III would be our 80-column business machine and have 90 percent of our market. The Apple II would be our 40-column home/school machine and have 10 percent of our market. The entire executive staff was sure that once the Apple III was out, the Apple II would stop selling in six months. I felt really down, because this 10 percent were my friends—the hobbyists and home users.

The Apple III hurt Apple in many ways, but it was a very well conceived product. And because we were so successful with the Apple II, we decided to build in an Apple II emulation mode to take advantage of all the software that was out there. The emulation mode did get built in, but, because of our concept of market separations, it was a very limited emulation. While our Apple II customers were adding 80-column cards and 16K RAM cards to their machines, we actually added chips to the Apple III to prevent access to many of its features during emulation mode. In emulation mode you only had access to 48K of memory—you couldn't use the 80-column display, the extra graphics modes, or the extra memory. The emulation mode wouldn't even run much of the existing Apple II business software, and there wasn't much Apple III software available.

Originally, we planned to deliver four applications with the Apple III—word processing, a spreadsheet, business graphics, and a database program. Steve Jobs's thinking at the time was, "People don't really want to buy a computer. They don't want to know about microprocessors or cards or buses. They want to buy VisiCalc—they want to buy a solution." So we were going to provide the four major solutions. But because we were having problems managing the Apple III project while we were building our management structure, we were only able to deliver our operating system—SOS—and VisiCalc, which was done by Personal Software [which later became VisiCorp].

The Apple III shipped very late and had 100 percent hardware failures. This is very subjective, and some people might disagree with me, but I think we were trying to be too pure. We wanted to do it on one PC board, not two, and it didn't fit on one PC board. So we got a company that could put three traces between two IC pins, had them do the PC board, and 100 percent of the Apple IIIs failed.

The Apple III is really very good, but we spent three solid years keeping the Apple II down, and now it's finally being allowed to grow in that direction. We've come out with ProDOS, which is a major improvement, and the ProFile [hard disk] is available for the Apple II now. It's a good start. I think they are going to find out that allowing the Apple II to get there will improve the whole Apple image.

The III will do very well in its established vertical markets forever, but it really won't make the huge success we thought it would. It may have the best chance it's ever had. ProDOS is the best way to get someone closer

(continued)

'We did SOS 3 years ago, and the rest of the world hasn't caught up.'

to SOS. We did SOS three years ago, and the rest of the world hasn't caught up or come close to it. Macintosh went in a different direction, so I can't compare the two systems.

BYTE: *Is SOS really that good?*
WOZNIAK: I think it's the finest operating system on any microcomputer ever. It's the greatest thing in the world, but I wish we gave out listings of it.

BYTE: *Wasn't it the first commercial system that actually had installable device drivers?*
WOZNIAK: Yes, the Apple II uses device drivers in ROM, on the I/O cards, but they won't work on the III because they depend on specific memory locations. On the III, you load a device driver into RAM for any device you add to a system, so it's infinitely flexible. You can always change it, correct bugs, and it's clean. But it's more difficult for outside manufacturers, because they have to supply a disk and instructions on how to update your system. It would have been the best of both worlds if you could plug in a card with a ROM on it and if the first byte in the ROM were a 12, for example, the system would recognize that the ROM holds a device driver and link to it automatically. That would have made it much easier for the card manufacturer. It would have been really easy to allow both techniques, but the Apple III engineering group didn't want to do anything the way it was done on the II. Marketing just didn't have enough leadership and control.

Anyway, having the Apple III as a failure didn't really hurt the company much. The Apple II was still very healthy, but for the next three years the Apple III hurt the company tremendously because everyone in Apple knows how great a machine the Apple III really is. It's a very clean machine, it's easy to use, and it's really been organized right with the operating system.

Unfortunately, we made it very difficult for anyone to get access to the insides of the machine. We had hired some very bright people who figured, "This is the right way it should be done. So we'll give out enough information to do this and we won't give them any more, because they might try to do something they're not supposed to do." The right way for one person is not the right way for another. We closed that machine up to where somebody could have a very difficult time finding out how to add their own I/O drivers. We did not make it easy for the outside world. We thought we wanted all of the markets for ourselves.

You have to let the end users develop their own standards. You've got to give them the freedom to discover how they're going to use an operating system, what sort of things they're going to buy. And if you're really right and have provided a good solution, that's where they're going to settle. The thinking on the III was very much like a religion in that it could only be done one way—our way. We made it very difficult for outside developers, instead of providing all the information as we did with the Apple II.

BYTE: *Has that attitude changed now?*
WOZNIAK: No. It's still the most negative thing in our whole company, and it will be for years.

I think that when a new market

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evolves, like personal computers did, there's a period of time when you've got to let the world go in all random directions, and eventually it will subside because it wants standardization. Then, once it's obvious what the standards are, they should be heavily supported by the manufacturer. You can't try to dictate a standard.

The Apple II and the Apple III

When we came out with the Apple III, the engineering staff canceled every Apple II engineering program that was ongoing, in expectation of the Apple III's success. Every single one was canceled. We really perceived that the Apple II would not last six months. So the company was almost all Apple III people, and we worked for years after that to try and tell the world how good the Apple III was, because we knew.

There is a lot to somebody's perception or image of a machine and how good it is. How many of my friends have them? How many people in the world have them? The Apple III was a failure the first year as a product—it had a bad image. When you give a bad first impression, you can go for five years trying to overcome it.

If you looked at our advertising and R&D dollars, everything we did here was done first on the III, if it was business related. Then maybe we'd consider doing a sub-version on the II. To make sure there was a good boundary between the two machines, anything done on the II had to be done on a lower level than on the III. Only now are we discovering that good solutions can be implemented on the II.

The Apple II was kept out of the business market to keep the III going, to give our users only one choice. We wanted to make the III the success it hadn't become and that it deserved.

Unfortunately, we made sure that the Apple II was nowhere close to the market that the [IBM] PC took. We made sure the Apple II was not allowed to have a hard disk or more than 128K of memory. At a time when outside companies had very usable schemes for adding up to a megabyte of memory, we came up with a method of adding 64K to an Apple IIe, which was more difficult to use and somewhat limited. We refused to acknowledge any of the good 80-column cards that were in the outside world—only ours, which had a lot of problems.

At one point during the Apple III development, I wrote some fast disk routines for our Pascal system on the II. And I got a lot of flak from Apple III engineers who felt that they shouldn't go on the Apple II. Nothing on the II should be allowed to run as fast or faster than the Apple III. That was the thinking that stuck with the company for three solid years.

It was unfortunate the way things worked out, because we probably put $100 million in advertising, promotion, and research and development into a product that was 3 percent of our revenues. In that same time frame, think what we could have done to improve the Apple II, or how much could have been done by Apple to give us products in IBM's market.

BYTE: *Are you putting more resources to work in that direction now?*

WOZNIAK: Yes, but things don't change in six months. In the Apple III we had a beautiful machine, and we spent a lot of money to try and emphasize that. We were trying to force the world to finally accept the machine because we knew just how good it was.

The PCjr had a poor initial reception like the Apple III did. It came out in the wrong month—the month when Macintosh was going to be perceived as the leader. The PCjr was perceived as an uninteresting product.

They may try for three years to overcome its bad first impression. They may put a lot of their corporate resources into trying to promote the PCjr and lose sight of the PC. The PC will keep selling because it's been accepted and there are a lot of aftermarket companies out there selling software and hardware for it. But if IBM neglects it enough, we may have a chance to turn it over on them in the next few years if we have a better product. ■

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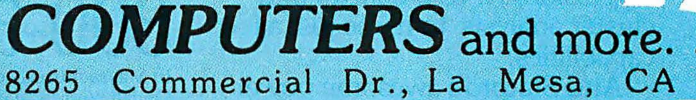
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BY WILLIAM RYNONE

UNINTERRUPTIBLE POWER SUPPLIES

Devices to save you from losing data in the dark

Advertisements for uninterruptible power supplies (UPSs) proliferate in computer magazines. But do you know what they are or how to buy one? This article should help answer your questions.

Many users of small computers have suffered the nasty consequences of an electrical power loss while operating their systems. You can lose a long file that is in working memory. Your disk head may crash, destroying a floppy disk or doing irreparable damage to a Winchester or cartridge disk. Most disk destruction occurs when the computer is reading from or writing to the disk at the instant of power failure. Consequently, serious damage can result should you panic at the flickering of your overhead lights and attempt to "save" your work.

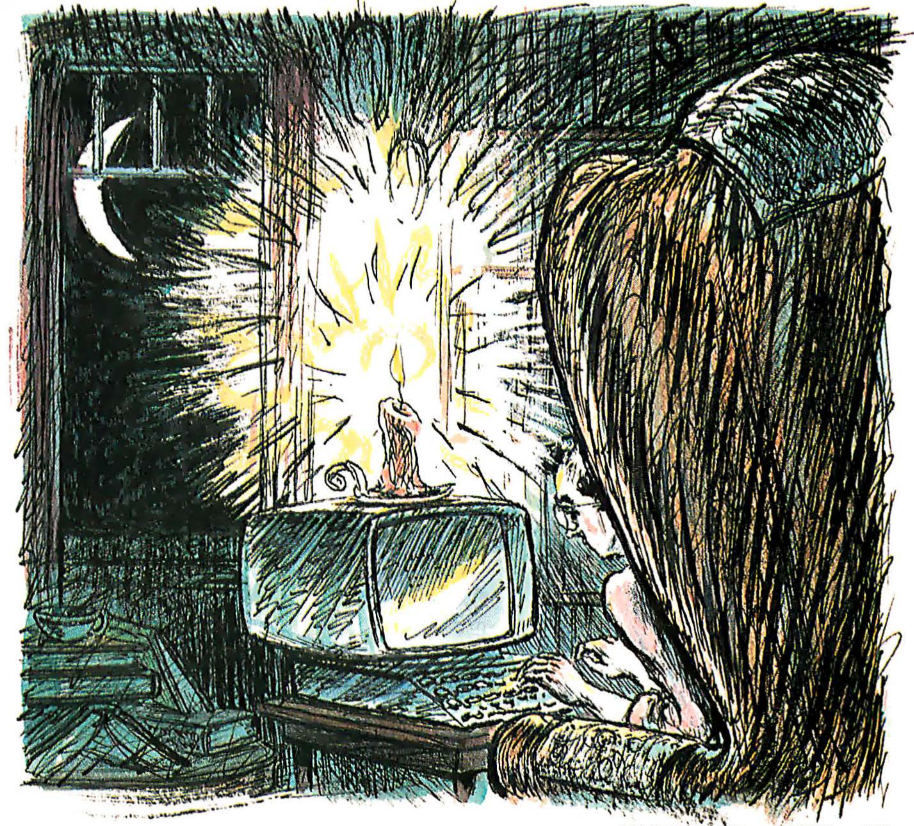
One way to temporarily retain your working data during a power failure is to connect batteries to the power-supply bus lines. For an S-100 system you'll need three different battery voltages: +8 volts (V), +16 V, and −16 V. This is a short-term solution, acceptable only if power returns within a reasonable period (that is, before the batteries die).

Though the preceding measure may protect data in working memory, your computer must maintain 117 V AC in order to store and retrieve data. Unless full power returns, you won't be able to save your data. And, of course, if the batteries can maintain only bus voltages, your disk hardware remains unprotected; you may have already experienced a head crash.

Another alternative to protecting both data in active memory and your hardware is to use a source of 117-V AC power that is independent of the anomalies of your local public utility. There are two approaches to this method: continuously supply power

(continued)

William Rynone teaches in the department of electrical engineering at the U.S. Naval *Academy* (Annapolis, MD 21402).



ILLUSTRATED BY STEVE SALERNO

to your computer with a continuous-duty UPS or supply power only when the electricity fails, using a standby power supply. (In this article, I'll use the term UPS to describe both types of units, differentiating when necessary.)

A continuous-duty UPS supplies power to your computer all the time. The 117-V AC power is developed by a static inverter that uses a storage battery, or batteries, depending upon your power requirements. The batteries are continually charged by power from your local utility. Simultaneously, the inverters are synchronized to the utility-line frequency—60 Hz—to eliminate any undesired effects upon the computer system. Such an effect might be a beat frequency between the utility's power and the frequency of the power generated by the free-running static inverter.

Under normal operation, the inverter frequency is maintained in power-line sync via a phase-locked loop circuit quite often operated in conjunction with a ferroresonant circuit, which may be thought of as a tuned inductance-capacitance oscillator. When the line power disappears, the inverter frequency drifts slowly to a factory-preset 60 Hz. The line frequency must change gradually so as not to induce any transients. Similarly, when power returns, the frequency of the inverter is gradually synchronized with the power company's line frequency. Many continuous-duty UPSs are designed to switch the computer input connections back to the utility's power line when the inverter fails.

Standby UPSs are maintained in a ready state with their battery, or batteries, receiving a trickle charge. When the utility's power-line voltage falls below a preset level, the inverter

Table 1: *Standby uninterruptible power supplies compared according to manufacturer specifications. Some information may have changed since press time.*

MANUFACTURER	MODEL	PRICE PER UNIT	POWER RATING (WATTS)	CUT-IN VOLTAGE	TRANSFER BACK TO LINE
Cuesta Systems Inc. 3440 Roberto Court San Luis Obispo, CA 93401 (805) 541-4160	9012060	$350	90	102 V	106 V
	20012060	$495	200	102 V	106 V
Electronic Protections Devices POB 673 Waltham, MA 02254 (800) 343-1813	Grizzly 200 (with surge protection)	$895	200	93 V	97 V
General Power Systems 1400 North Baxter St. Anaheim, CA 92806 (714) 956-9321	GPS-0.1K126R	$495	100	102 V	109 V
	GPS-0.2K126R	$595	200	102 V	109 V
	GPS-0.3K126R	$695	300	102 V	109 V
	GPS-0.5K126R	$895	500	102 V	109 V
Kalglo Electronics Co. 6584 Ruch Rd. Bethlehem, PA 18017 (800) 524-0400	LS-240	$485	240 VA	102 V	106 V
	LS-480 (both have multistage surge suppression and RFI filtering)	$795	480 VA	102 V	106 V
Meirick Inc. Power Systems Division POB 298 Frisco, CO 80443 (303) 668-3251	MI 400	$495	400	102 V	106 V
	MI 800 (both have surge protection and spike and line filtering)	$795	800	102 V	106 V
PTI Inc. 320 River St. Santa Cruz, CA 95060 (408) 429-6881	Datashield PC-200	$359	200 (240 VA)	108 V	102 V
	XT-300	$499	300 (380 VA)	108 V	102 V
	MU-800 (all have spike, EMI, and RFI protection)	n.a.	800 (1000 VA)	108 V	102 V

is switched in. A simple relay coil that detects the loss of power-line voltage can trigger the switch. In other cases, very elaborate electronic sense circuits can trigger the standby UPSs, based upon parameters such as the absolute line voltage, the rate of decay of the line voltage, the occurrence of line transients, or whether the frequency and phase of the inverter are in sync with the decaying utility-line voltage.

UPSs are classified in different ways. Manufacturers may specify a voltage level at which the standby UPS will be activated—the "cut-in level"—or they may specify a switching time for the UPS to come on line—the "reaction time"—when there is a complete loss of power. Neither figure by itself is adequate for making a purchase decision. One UPS cut-in voltage may be sufficient to power your system, but it may have a long reaction time. A long reaction time can result in a loss of data in working memory. Even more serious is the probability of disk-drive damage that can occur during a lapse of 117-V AC power. Another manufacturer rates the reaction time of its standby UPS at less than one cycle of the AC line voltage, equal to 16⅔ milliseconds (ms). However, the cut-in level when the line voltage is decreasing slowly is 80 V rms (root mean square), well below the necessary 117 V AC. The effect on your computer components at this level is, at best, unpredictable.

How critical is the reaction time relative to your hardware? Your main system box contains large filter capacitors if it uses linear power supplies (with switching power supplies, capacitor filtering may be minimal), and a 10- to 25-ms reaction time for a UPS won't significantly affect operation.

(continued)

ALLOWABLE LOAD POWER FACTOR	TRANSFER TIME OF UTILITY TO UPS	OUTPUT VOLTAGE	EXTERNAL BATTERY TERMINALS	OPERATING PERIOD ON INTERNAL BATTERY AT RATED LOAD
does not matter	10 ms maximum; 8 ms typical	102 – 132 V, stepped sine wave	yes, 10.8 – 14 V	at least 5 minutes at full load; at least 15 minutes at half load
does not matter	10 ms maximum; 8 ms typical	102 – 132 V, stepped sine wave	yes, 10.8 – 14 V	at least 5 minutes at full load; at least 15 minutes at half load
1.7 A at 200 W	8 ms maximum	102 V AC, stepped sine wave	no	20 minutes at full load
0.8	less than 2 ms	115 V AC	yes	9 minutes at full load
0.8	less than 2 ms	rms	yes	16 minutes at full load
0.8	less than 2 ms	rms	yes	18 minutes at full load
0.8	less than 2 ms	rms	yes	10 minutes at full load
0.6	4 ms maximum	120 V AC, modulated pulse-width output	yes, 12 V nominal	11 minutes at full load; 27 minutes at half load
0.6	4 ms maximum	120 V AC, modulated pulse-width output	yes, 24 V nominal	11 minutes at full load; 27 minutes at half load
0.8	4 ms ± 2	140 V square wave; 115 V AC under load	yes, 12 V nominal	20 minutes at full load; 45 minutes at half load
0.8	4 ms ± 2	140 V square wave; 115 V AC under load	yes, 24 V	9 minutes at full load; 20 minutes at half load
doesn't matter for these models	10 ms maximum; 4 ms typical	120 V AC, phase-shifted square wave	no	at least 5 minutes at full load; at least 20 minutes at half load
	4 ms maximum; 1 ms typical	120 V AC, phase-shifted square wave	yes, 12 V	at least 5 minutes at full load; at least 20 minutes at half load
	10 ms maximum; 4 ms typical	120 V AC, sine wave	yes	at least 6 minutes at full load; at least 25 minutes at half load

Table 1: *continued*

MANUFACTURER	MODEL	PRICE PER UNIT	POWER RATING (WATTS)	CUT-IN VOLTAGE	TRANSFER BACK TO LINE
Qubie' 4809 Calle Alto Camarillo, CA 93010 (800) 821-4479	SB200	$329	200	108 V	108 V
	XT300 (both have surge and EMI protection)	$429	300	108 V	108 V
R. H. Electronics Inc. 566 Irelan Dr. Buellton, CA 93427 (805) 688-2047	Guardian Angel (20012060)	$495	200	102 V	106 V
	Power Angel	n.a.	800	102 V	106 V
SAFT America Electronic Systems Division 2414 West 14th St. Tempe, AZ 85281 (602) 894-6864	200 VA	$549	200 VA	102 V***	106 V
	400 VA (both have spike protection)	$749	400 VA	102 V***	106 V
Sun Research Inc. POB 210 Old Bay Rd. New Durham, NH 03855 (603) 859-7110	M60	$400	150 VA	104 V	110 V
	M60 + S	$475	150 VA	104 V	110 V
	M60 + 3	$525	300 VA	104 V	110 V
	M60 + 3S	$700	300 VA	104 V	110 V
	M60 + 6	$900	600 VA	104 V	110 V
	M60 + 6S	$1140	600 VA	104 V	110 V
	Mayday	$240	150 VA	104 V	110 V
	Mayday + S	$325	150 VA	104 V	110 V
	Mayday + 3	$350	300 VA	104 V	110 V
	Mayday + 3S	$500	300 VA	104 V	110 V
	SR3	$595	300 VA	104 V	110 V
	SR6 (+S indicates surge protection)	$995	600 VA	104 V	110 V
Topaz Electronics 9192 Topaz Way San Diego, CA 92123 (619) 279-0831	84461	$760	400 VA	102 V	110 V
	84462	$820	400 VA	102 V	110 V
	84462-01*	$870	400 VA	102 V	110 V
	84864	$970	800 VA	102 V	110 V
	84864-01*	$1020	800 VA	102 V	110 V
	84126-01*	$1085	1000 VA		
Tripp Lite 500 North Orleans Chicago, IL 60610 (312) 329-1777	BC-200	$359	200	85 V**	
	BC-425	$559	425	85 V**	
	BC-1000 (all have surge protection)	$1179	1000	85 V**	

* with status monitor
** may be used in series with vendor's brownout protection system; as supplied, the BC series is for complete blackout protection only
*** option for higher specification available

ALLOWABLE LOAD POWER FACTOR	TRANSFER TIME OF UTILITY TO UPS	OUTPUT VOLTAGE	EXTERNAL BATTERY TERMINALS	OPERATING PERIOD ON INTERNAL BATTERY AT RATED LOAD
doesn't matter for these models	10 ms maximum; 4 ms typical	120 V	yes, 12 V	5 minutes at full load; 20 minutes at half load
	4 ms maximum, 1 ms typical	120 V	yes, 12 V	6 minutes at full load;. 20 minutes at half load
	10 ms maximum; 4 ms typical	102 V – 132 V rectangle sine	yes	2 – 6 minutes at full load; 15 minutes at half load
	10 ms maximum; 4 ms typical	120 V ± 3.5 V sine wave	no	12 minutes at full load; 35 minutes at half load
0.8	6 ms maximum; 4 ms typical	117 V ± 15%, square wave for both models	optional, 24 V	20 minutes at full load; 50 minutes at half load
0.8	6 ms maximum; 4 ms typical		optional, 24 V	10 minutes at full load; 24 minutes at half load
	16 ms maximum; 8 ms typical	120 V rms;	all models except	at least 30 minutes at full load for
	16 ms maximum; 8 ms typical	+ 3 V over 80%	SR6 have external	all models except SR3 and SR6,
	16 ms maximum; 8 ms typical	of battery energy;	battery terminals;	which have a period of at least
	16 ms maximum; 8 ms typical	sine wave;	SR6 has an internal	15 minutes at full load
	16 ms maximum; 8 ms typical	5% harmonic	gel	
	16 ms maximum; 8 ms typical	distortion		
	8 ms maximum	120 V, square wave		
	8 ms maximum	120 V, square wave		
	8 ms maximum	120 V, square wave		
	8 ms maximum	120 V, square wave		
	8 ms maximum	120 V, square wave		
	8 ms maximum	120 V, square wave		
doesn't matter for these models	10 ms maximum; 4 ms typical	120 V ± 3.5 V, sine wave for all models	no for all models	at least 9 minutes at full load; 25 minutes at half load
	10 ms maximum; 4 ms typical			at least 35 minutes at full load; 75 minutes at half load
	10 ms maximum; 4 ms typical			at least 35 minutes at full load; 75 minutes at half load
	10 ms maximum; 4 ms typical			at least 12 minutes at full load; 35 minutes at half load
	10 ms maximum; 4 ms typical			at least 12 minutes at full load; 35 minutes at half load
				at least 9 minutes at full load; 30 minutes at half load
doesn't matter for these models	10 ms maximum	120 V AC, rectangular wave for all models	no for all models	10 minutes at full load; 30 minutes at half load
	10 ms maximum			10 minutes at full load; 30 minutes at half load
	10 ms maximum			16 minutes at full load; 38 minutes at half load

Table 2: *Continuous-duty uninterruptible power supplies compared according to manufacturer specifications. Some information may have changed since press time.*

MANUFACTURER	MODEL	PRICE	POWER RATING (WATTS)	POWER FACTOR	BYPASS UPS TO UTILITY
Computer Power Inc. 124 Main St. High Bridge, NJ 08829 (201) 735-8000	OUPS48-500	$1650	500	0.75 lag to 0.9 lead for all models	yes, 1 second
	OUPS48-750	$1750	750		yes, 1 second
	OUPS48-1000	$1975	1000		yes, 1 second
	UPS36-500M				
	– with lead-antimony battery	$1690	500		yes, less than 1 second for all UPS36 and UPS48 models
	– with small gel battery	$1710	500		
	– with large gel battery	$1795	500		
	UPS36-750M				
	– with lead-antimony battery	$1795	750		
	– with small gel battery	$1860	750		
	– with large gel battery	$1940	750		
	UPS36-1000M				
	– with lead-antimony battery	$2075	1000		
	– with small gel battery	$2140	1000		
	– with large gel battery	$2220	1000		
	UPS48-1500M				
	– with lead-antimony battery	$3500	1500		
	– with small gel battery	$3565	1500		
	– with large gel battery	$3645	1500		
Electronic Protections Devices POB 673 Waltham, MA 02254 (800) 343-1813	Grizzly 500	$2400	500	0.8	standard at 125% overload for both models
	Grizzly 1000 (both have surge protection)	$5200	1000	0.8	
RTE Deltec Inc. 2727 Kurtz St. San Diego, CA 92110 (619) 291-4211	3056	$1995	500	1	standard
	DSU-720	$2995	700	0.8 to 1	optional
	DSU-1220	$3395	1200	0.8 to 1	optional
	DSU-1820	$3895	1800	0.8 to 1	optional
	7026	$6295	2500	0.7 to 1	standard
Sun Research Inc. POB 210 Old Bay Rd. New Durham, NH 03855 (603) 859-7110	Mayday 60 + 3C	$800	300 VA	1 for all models	optional on all models
	Mayday 60 + 6C	$1325	600 VA		
	Mayday 60 + 10C	$2295	1000 VA		
	SR30	$995	300 VA		
	SR60	$1495	600 VA		
	SR100 (220 V in, 110 V out)	$2395	1000 VA		
	SR150 (220 V in, 110 V out)	$3195	1500 VA		

POWER SUPPLIES

OUTPUT VOLTAGE	BATTERY CONNECTION OR INTERNAL BATTERY AT RATED LOAD
120 V AC, sine wave for all models	OUPS48 models operate on external battery
	120 minutes at full load
	50 minutes at full load 120 minutes at full load
	75 minutes at full load
	30 minutes at full load 75 minutes at full load
	50 minutes at full load
	20 minutes at full load 50 minutes at full load
	40 minutes at full load
	20 minutes at full load 45 minutes at full load
120 V AC, sine wave	both models have 60-V external battery; 15 minutes at full load, 12 minutes at half load
120 V AC, sine wave, 5% THD DSU models offer user-selectable sine wave, 5% THD	48-V external battery 72-V external battery on all DSU models
120 V AC, sine wave, 5% THD	72-V external battery
120 V AC, sine wave for all models except SR100 and SR150; for those models, 110 V AC, sine wave	24-V external battery 24-V external battery 48-V external battery 12-V internal gel 24-V internal gel SR100 and SR150 offer choice of lead-sulfate battery or internal gel

CONSTRUCTING AN EMERGENCY LIGHT SOURCE

Unless you enjoy programming in the dark, an auxiliary light source adjacent to your UPS-protected computer is a wise idea. I use a high-intensity desk lamp that incorporates a 12-V automobile taillight bulb and a built-in 12-V transformer. Break the lead to the lamp where shown in figure A, add relay K1, and connect the battery and other wires. While the 117-V power is available, the lamp is lighted from the 117-V line. During a power failure, the relay contacts switch the lamp to the 12-V battery. You can add a single-post, single-throw switch, S1, if you want the option of turning the emergency lighting on and off to conserve battery power.

Another alternative, albeit more complicated, is shown in figure B. With this design, you can modify your high-intensity lamp with all solid-state (no relay) circuitry and include battery-charging capabilities. When nearly fully charged, the 12-V car battery will receive a trickle charge of about 30 milliamperes, guaranteeing many hours of emergency lighting from a fresh battery.

A photocopy of the printed-circuit board artwork is available from William Rynone Sr., POB 292, Ocean Gate, NJ 08740. You must include a stamped self-addressed envelope.

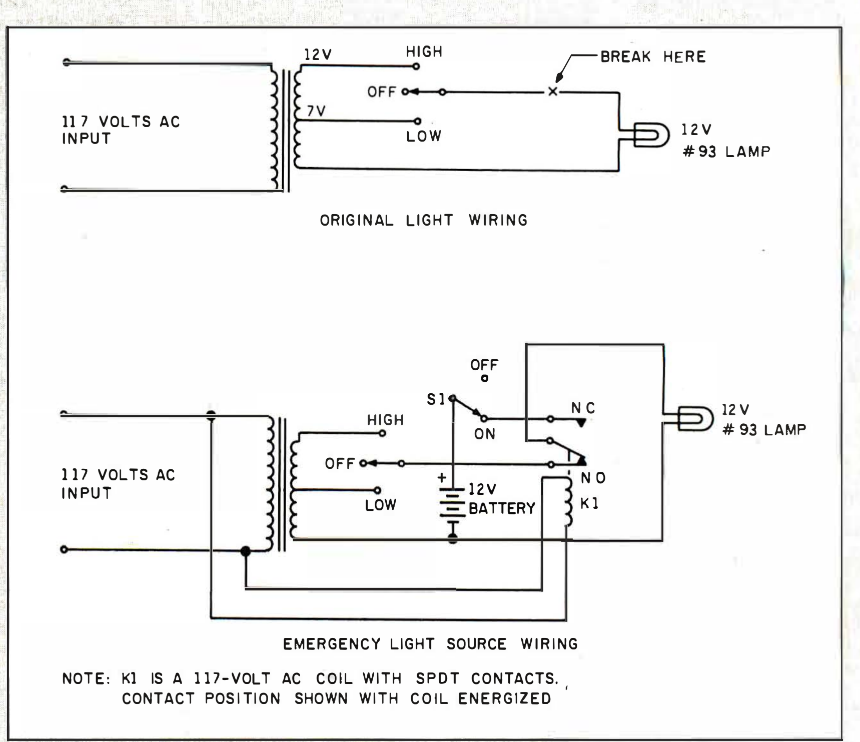


Figure A: *This emergency lighting setup powered by a UPS can keep you from computing in the dark. (Original schematic by Barbara Campo.)*

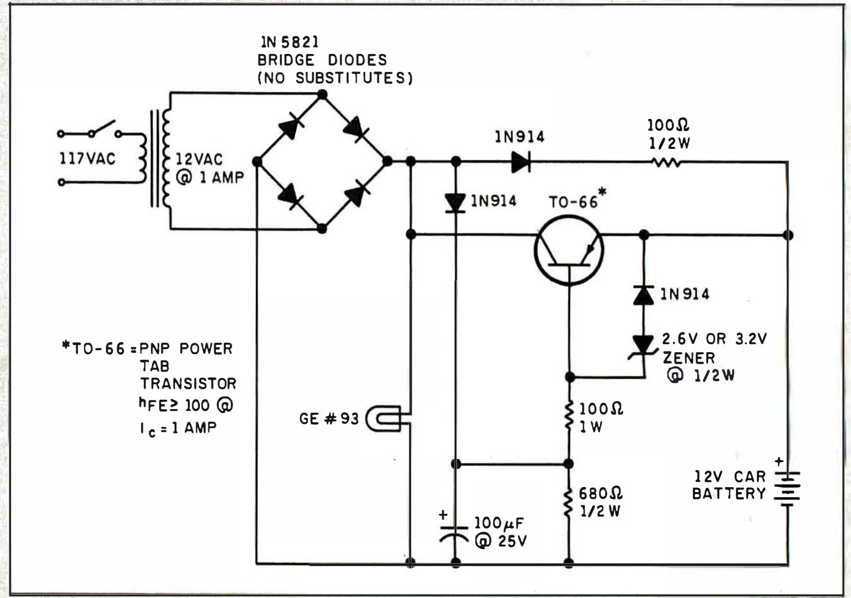


Figure B: *A high-intensity lamp modification with backup power source and battery-charging capabilities. Schottky diodes must be used in the bridge in order to maintain adequate lamp brilliance. Any PNP power-tab mount (TO-66) transistor with a gain of 100 at 1 ampere will work with this design.*

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Floppy-disk drives are not as well protected. They can generally be divided into two types: those with DC motors and those with AC motors. Those with DC motors are de-energized when not reading or writing to disk, but they have heads that are in continual contact with the disk. Drives with AC motors contain read/write heads that are lowered into position only during data transfer. As long as the filter capacitors are large enough to sustain voltage above TTL (transistor-transistor logic) minimum levels, you will not lose data. However, if the head is traveling across the disk, a sudden power loss—below 117 V—can result in a scratched floppy disk.

Winchester drives are an exception. Their heads require a nominal 15 seconds to be lifted to the normal operating position and a comparable time to be de-energized. It appears, therefore, that a 25-ms loss of power should have no detrimental effect. Some 5¼-inch Winchesters do have an electromechanical brake that activates at approximately 9 V, making it difficult to predict what will happen to them at different levels of power loss.

UPS Shopping Questions

Here are some appropriate questions to ask when shopping for a UPS device. Questions 2 through 9 are particularly applicable to standby UPS units.

1. Should I purchase a continuous-duty or a standby UPS? (A quality standby UPS may perform acceptably at a considerable savings.)
2. What is the power rating of the UPS? If it has a built-in battery, how long will the battery supply power at a usable voltage level? Will the vendor supply an output-voltage versus time curve for its UPS unit under rated power conditions?
3. You may wish to purchase a UPS with reserve power to accommodate future computer components. How much 117-V rms output voltage variation will occur if the unit is not used at its rated load power? That is, how well is the output voltage regulated? Will the vendor supply an output-voltage versus percent-of-rated-load power curve for its UPS? (This question is appropriate because the intermittent operation of disk drives and printers causes variations in the load current that must be supplied by the UPS.)
4. Are terminals available on the case of the UPS whereby an external battery may be employed (thus enabling a longer operating period)? If so, what voltage must the external battery be? (Twelve volts is desirable, so a low-cost car battery may be used.)
5. Will overheating problems occur if operated with an external battery for an extended period? How long can you operate?
6. Is the UPS unit available without the internal battery? (You may decide to use a 12-V car battery.)
7. To what voltage must the power line decrease before the UPS activates? Does the UPS activate at the same voltage value for slowly as well as rapidly decaying line voltages? Does it employ a phase-locked loop circuit with gradual line frequency capture circuitry?
8. In the event of a sudden and complete loss of power, what is the switching time for the standby unit to "cut in"?
9. Is delay circuitry included in this product? (Delay circuitry can keep the unit on line for a period of time after it has been activated by line transients, thus giving the power company's line voltage an opportunity to settle.) If so, what is the delay period?
10. Is the output of the UPS sine wave or square wave? (Some printers malfunction with a square-wave power source. If you're content to save some data and power down your computer, the UPS output waveshape might not be important, and you could purchase a lower-cost unit. A sine-wave unit may cost two to three times as much as an equivalent square-wave unit.)
11. Most microcomputer users already have line transient suppressors. Is the UPS available without this built-in circuitry? If not, can you connect an existing multi-outlet power strip with surge-suppression capability to the output of this UPS without excessive voltage drop?
12. Who services the UPS? (Hong Kong is rather inconvenient.)

The Price of Power

The price of uninterruptible power is a purchase factor. A low-power continuous-duty UPS may cost three to four times more than a standby UPS of equivalent rating. Power ratings of UPSs may be as low as 100 watts or up to many kilowatts. Your home computer doesn't need that much protection. These high-kilowatt units are used by banks and hospital operating rooms.

You can determine the UPS power required to protect your system by adding the individual power ratings of each component. You'll find the power ratings for the central processing unit, disk drives, video-display terminal, and printers on each manufacturer's nameplate or in the accompanying data sheets. If you own a totally integrated computer system, you'll find only one power rating. You may want to purchase a UPS with a slightly greater power rating than your system requires. The extra power will enable you to add one or more new components.

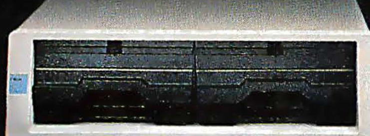
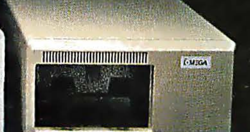
Tables 1 and 2 are based upon information supplied by UPS manufacturers. In some instances their data was incomplete and would not help a reader answer the "consumer" questions that accompany this article (see "UPS Shopping Questions" at left).

A common power rating for standby UPSs used in typical home computer systems is 150 to 200 watts. These units operate on their built-in battery, or batteries, for about 20 minutes. This is just enough time to complete important data entry, albeit by flashlight or candlelight, and save your work (see "Constructing an Emergency Light Source" on page 190). ■

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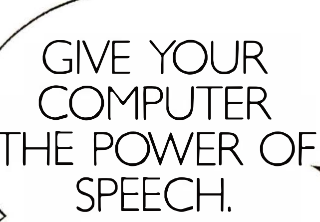
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BY RICHARD S. SHUFORD

AN INTRODUCTION TO FIBER OPTICS

PART 2: CONNECTIONS AND NETWORKS

Optical fibers are becoming practical for use in applications such as local networks

Editor's note: Last month we looked at the new technology of optical-fiber waveguides and examined their fundamental principles. This month we'll concentrate on the more practical aspects of fiber optics: how they are connected together and how they are being used in computer communications.

The rapid development and change of the fiber-optics industry is evident in microcosm in the little parts that enable the major components of a fiber-optic system to be fitted together: the connectors. Established electronic-connector companies are in hot competition with unknown upstarts to develop, patent, and sell the fiber-optic cable connector that will become the equivalent of the audio-equipment "phono" plug or the coaxial-cable PL-259. The SMA 905 and 906 connectors for multimode fibers, made by Amphenol, AMP, Optical Fiber Technologies Inc., and a few others, are candidates (at least in commercial systems), but their role is not yet a dominant one.

To the user of a fiber-optic system, the continued competition indicates that none of the connectors hitherto available have been really satisfactory in all respects. Among their defects have been high price, fragility, high loss, noninterchangeability, difficulty of installation, and uncertainty of supply. Fortunately, the majority of the products on the market have overcome most of these flaws, but the connectors all seem to have at least one drawback.

Most of the connector designs now in wide use require a good deal of expertise as well as special polishing or test equipment for proper installation. Many of the ones with low loss must be assembled using an epoxy adhesive to hold the optical fiber in alignment; the epoxies often require exposure to an ultraviolet curing light or high temperatures. Furthermore if, once the epoxy has cured, the fiber alignment is unsatisfactory, the connector has to be cut off and discarded.

Engineers laying out a fiber-optic communication link have to pay close attention to the total signal loss in the system. Transmitter and receiver gain are weighed against the losses caused by each passive system component; the balance sheet of gain and loss is called the *flux* or *power budget*. In systems that have many connections between the transmitter and receiver, as is often the case in a computer local network, the connectors usually introduce more loss than any other factor. There is also a trade-off between the quality of the connection produced and the ease of installing the connector: the easiest to install are the most lossy. With really tight power budgets, installers have to resort to the difficult but effective *fusion splice* for joining fibers, in which the cloven, stripped fiber end faces are precisely aligned and then melted together by subjecting them to an electric arc.

But new kinds of connectors and splices are being invented, and one of them may yet combine the virtues everyone is waiting for. For example, promising developments have appeared in the multimode *expanded-beam lens* (EBL) connectors. The lens in an

(continued)

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EBL connector spreads the light emerging from the attached fiber into a larger exit angle or, on the other side of the connection, gathers light from a larger region of space than would normally be permitted by the fiber's numerical aperture. Compared to other connectors, EBL connectors reduce the precision of fiber alignment required, but they tend to be expensive simply because they incorporate lenses, which have to be ground and then coated chemically to prevent power loss from extra reflection. However, at least one simplification has been made possible by new EBL designs now available from General Telephone and Electronics and from the Deutsch (pronounced "doysh") Corporation; these can be in-

(continued)

Driving the Fiber-Optic Ethernet Bus

The Ethernet was designed to use a network-access protocol called carrier-sense, multiple-access with collision detection (CSMA/CD). The inspiration for this, according to inventor Robert Metcalf, was the so-called "cocktail party algorithm": a man at a party wishes to speak, but first he listens, finding out if anyone else is already speaking. If he hears silence, he begins to talk. But if the woman next to him begins to speak at the same instant, neither will be understood by their listeners. So, each hearing the other, they both stop. After waiting for a brief moment, the man tries again to speak, and if the woman is inclined to wait for a slightly longer interval, the man succeeds in communicating.

A CSMA/CD computer network works essentially the same way. The transceivers at each node sense the state of the transmission medium (usually a coaxial cable) before attempting to transmit, looking for a carrier signal from another station's transceiver. Sometimes two devices attempt to transmit at once, but when this *collision* is detected, both stop and pause for a random interval before trying again. The likelihood of a collision is increased by delays of propagation along the length of the cable: by the time the signal from one station has traveled down the cable, another station has already started its own transmission, having heard nothing.

In Ethernet, a station can easily tell that a collision has occurred by sensing the DC voltage level on the coaxial cable, which becomes higher than usual when two stations are transmitting simultaneously. But a network in which signals travel through glass in the form of light waves cannot use DC voltages to detect collisions. Nor can it use comparison of the levels of light present in the optical fiber. Different levels of light arrive at various points in the system because of the attenuation of the light at each connection. Furthermore, the power emitted by optical transmitters varies—some emit twice as much light as others, and the sensitivity of receivers also varies. There is no practical way to use direct measurement of the transmitted signal as a reliable collision detector. A team of researchers headed by Richard P. Kelly at Siecor FiberLAN took this as a challenge in designing a fiber-optic network that would be compatible with Ethernet.

The researchers looked at some previous efforts to use an active central controller with a hybrid signal path (including work at Xerox's Palo Alto Research Center, where Ethernet was developed). In many such previous designs, transmissions coming over optical fibers from each network station were fed into an optical transceiver at the central node. The transceiver converted the signal into electrical form and then placed it on a metallic electrical bus, permitting collision detection to occur the same way as in the original Ethernet. The signal was then reconverted into modulated light and sent out on a second set of fibers to the other nodes.

But an active central node for propagating the signals negates one of the basic reasons for using the bus topology: the network could fail totally if anything goes wrong with the active central controller. (The same principle applies if active T-taps are used on a pure fiber-optic bus, although possibly only part of the network would fail.) So Kelly's team devised a clever alternative in which the physical bus of Ethernet is emulated by a passive optical multiplexer, the transmissive star coupler. For each network node, separate transmit and receive fibers (in a dual cable) are used, physically laid out in a star configuration and converging at a wiring center. The transmit lines enter the input side of the transmissive coupler, which divides the incoming light equally and broadcasts it to all the stations on the network over the receive lines (as shown in figure 4). Any collisions of transmissions occur inside the coupler.

However, at some point in the transmit line coming from the remote stations, an optical tap diverts a small amount of the optical power (around 10 percent) to separate fibers that feed a separate active collision detector. The collision detector has individual inputs for each network station, each feeding a receiver connected to one gate of a logical comparator. Whenever signals arrive simultaneously on more than one collision-detection line, a collision is known to be occurring. With multiple inputs active, the comparator emits an output signal to activate a "jam" transmitter that feeds the central coupler with a distinctive signal subsequently broadcast to all nodes. To find out if there has been a collision, the network nodes merely have to detect the special jam signal. If there is a failure in the collision detector, the network falls back into a somewhat less efficient mode of operation, without collision detection; data, however, can still flow throughout the system.

In this design, the passive transmissive coupler maintains the robustness of the bus topology, while the active collision detector allows complete interconnection and protocol compatibility with existing coaxial-cable Ethernet installations. And the efficiency of optical-fiber transmissions results in longer network segments, increasing from 500 meters to 2800 the distances that can be handled between nodes before repeaters are needed.

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Tone and Pulse Dialing	✓	✓	✓	✓	✓
Hayes Command Compatible (Works with Smartcom™)	✓	✓	✓	✓	
Additional telephone jack with exclusion switching	✓				
Analog loop back self test	✓	✓	✓		
Self Test at Power Up	✓		✓		
Call Progress Detection (Busy, Dial Tones, Trunk Busy, etc.)	✓		✓		
Speaker and External Volume Control	✓	✓	✓		
Full Complement of Status Lights	✓	✓			
8 Switch Selectable power-up defaults	✓	✓			
Adaptive Dialing	✓		✓		
Auto Redial on Busy	✓		✓		
Ergonomically designed easy to read front display panel	✓				
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Auto Logon Macros	✓
Auto message transmission to groups of numbers	✓
Records call duration	✓
12-character Alphanumeric Display	✓

*Comparison made by Prometheus on the basis of the best information available to Prometheus at time of printing.





stalled on multimode cables without special polishing of the fiber's face.

INTERCOMPUTER COMMUNICATION

Optical fibers are becoming an increasingly attractive medium for communication between computers. Organizations with large data-processing chores are discovering the efficiency and security of fiber optics for connecting computation centers that are a few miles apart. The small physical size of fiber-optic cables is no small advantage in upgrading an installation where cable ducts are already crowded. And fiber-optic links are beginning to appear where engineers planning for greater capacity recognize the potential for expanding the bandwidth by merely upgrading the interface equipment.

A significant new area of use is in the so-called "back-end" networks, connecting large-scale, high-speed processors to their attendant memory and peripheral devices. One of the projects of technical subcommittee X3T9.5 of the American National Standards Institute (ANSI) is the Fiber Distributed Data Interface, a back-end interface designed to use fiber-optic links at data rates of 100 megabits per second (Mbps).

But the application of most interest to users of personal computers is the lower-speed general-purpose local-area network (LAN), which connects workstations, file servers, and miscellaneous peripherals in an office or factory environment. Any local network that needs wide bandwidth, long cable runs between stations, immunity to electromagnetic interference, or high security is a candidate for fiber-optic cabling. And although an optical-fiber-based system costs initially somewhat more than an equivalent network built from copper twisted-pair wire or coaxial cable, the bandwidth of a fiber-optic system can be easily expanded later by merely changing the interface equipment.

LOCAL NETWORKS

If you've been following the recent commercial developments in local

networks, you know that battles are being waged over what is the best general-purpose network-node connection and layout scheme, or *topology*. The three major systems are the bus, the ring (or loop), and the star. The champions are well known: Xerox and Digital Equipment Corporation attacking on behalf of the bus, IBM stoutly defending the ring, and AT&T recently launching a kind of *Star Wars* offensive.

The inherent characteristics of fiber-optic technology cause its most natural network implementations to take the form of the ring or star. But currently, bus-type networks seem to have the best strategic position in the topology skirmishes, largely because of the success of the Xerox-developed Ethernet and its imitators. This poses somewhat of an obstacle to the use of fiber optics in many currently existing local networks; however, it is not an insurmountable one.

In figure 1, the bus, ring, and star topologies are shown in their idealized forms. A bus network has all its nodes connected directly to a single distribution medium; a signal broadcast by any node can be received by every other node. In a ring network, each node communicates directly only with the nodes immediately adjacent to it (in the logical sense), receiving on one side and transmitting on the other. Provisions are usually made to bypass a malfunctioning node. The star network features a central switching point that receives transmissions from the originating nodes and redirects or retransmits the data to the destination nodes; each node talks only to the central switch.

(Another distinction can be drawn between different kinds of networks. If the signals are transmitted in more or less raw form, the network is called *baseband*. If the data signals are modulated onto a very-high-frequency carrier signal, the network is called *broadband*. A broadband system can mix the computer data with other kinds of signals: telephone conversations, video images, etc. But the interface equipment for broadband is

(continued)

somewhat more complex.)

In addition to the physical connections between nodes, a network must have a traffic cop: some means of deciding what data from which nodes can be passed over the system. Several schemes for enabling the system to make this decision exist, each with good and bad points. The topology selected for a network will be a chief factor in deciding which network-access protocol is appropriate.

Both IBM and AT&T have announced support for fiber-optic links as part of a computer local network. At the time of this writing (November), IBM's commitment is limited to specifying an option in the IBM Cabling System for use of fiber-optic cables (in pairs, multimode 140-micron-cladding/100-micron-core type). IBM says it intends to implement a local network with a logical ring topology imposed on a star-shaped physical wiring setup, as in figure 2. Access to the network will be granted by a protocol based on passing a logical "token" around the ring. The centralized wiring closets in the announced cabling system are well suited to use of optical fibers. Some installations will probably be hybrids, with copper twisted-pair wire used for short runs and fiber-optic cables for longer links to distant nodes or between wiring

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closets; any interface needed from metallic to fiber-optic links would be installed in the wiring closet.

AT&T's Information Systems Network (ISN), tied closely to the technology of telephone private branch exchanges, will not use fiber-optic links to individual network stations; conventional four-pair metallic wiring will be run in a star layout from nodes to the central controller or to remote concentrators. However, the linkage from the concentrators to the controller will be over multimode fiber-optic links operating at 8.64 Mbps over distances up to 1 kilometer. The fiber-optic connections serve as extensions of two metallic signal buses inside the central controller, on which packets of data are passed according to a time-division multiple-access protocol before being redirected to their destinations (see figure 3).

Token-ring networks have been popular among Japanese designers, with Hitachi offering its fiber-optic SigmaNet and NEC (Nippon Electric Company) selling its C&C-Net Loop 6770. These systems contain several redundant features to assure continuous service in the event of a partial network failure, including duplicate transmission paths in the ring. Fujitsu Ltd. has exhibited the Optical Data Highway local network, but this ring (or loop) configuration uses time-division multiplexing instead of token passing. And some ring-based networks have appeared in Great Britain, where pioneering work was done on the Cambridge ring system.

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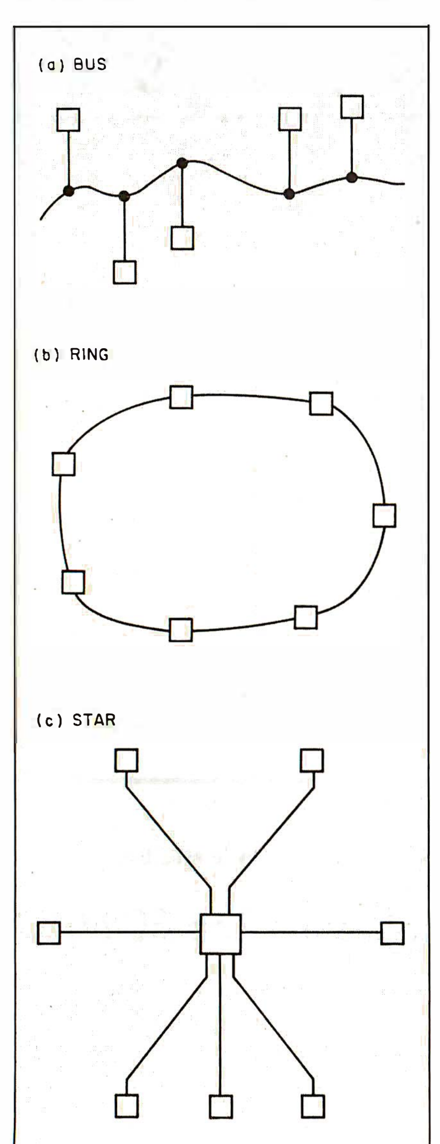


Figure 1: *The bus, ring, and star topologies (or connection configurations) shown in their idealized forms.*

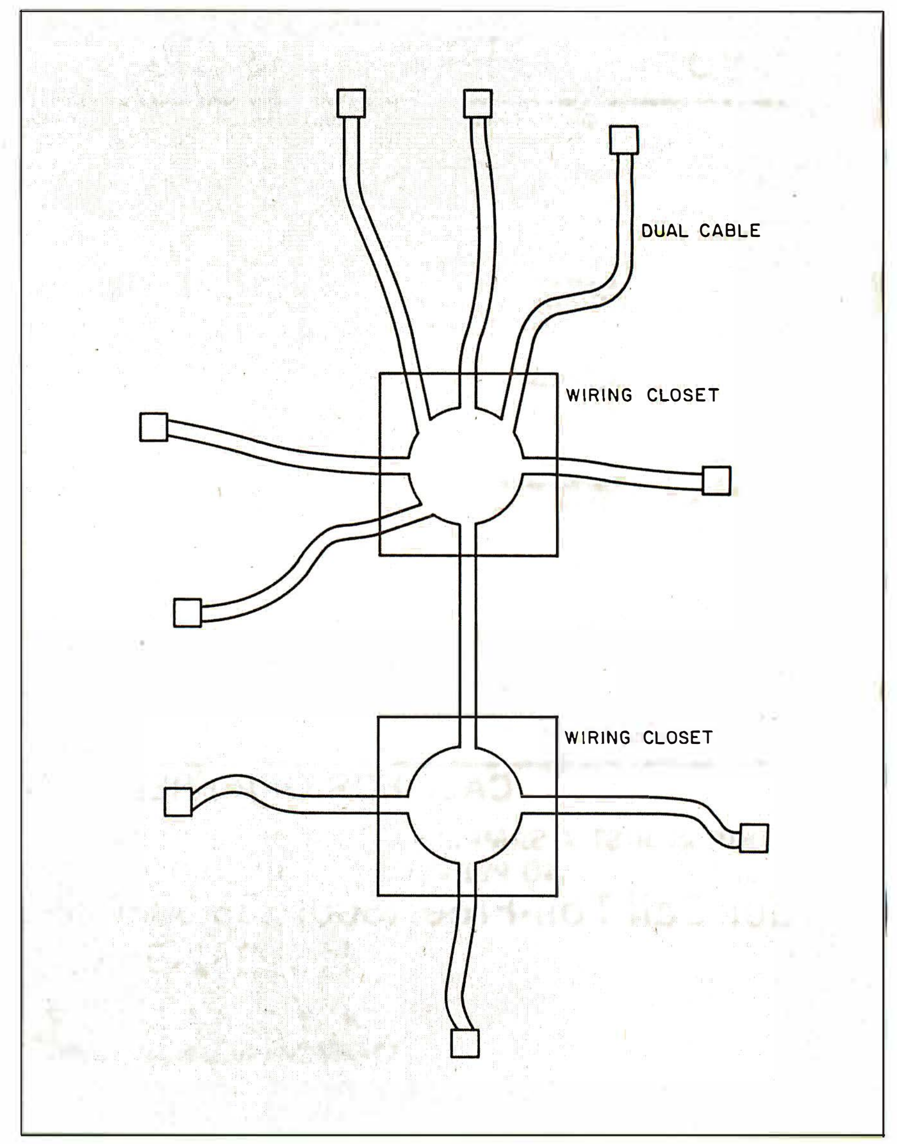


Figure 2: *IBM's predicted local network uses a logical ring topology imposed on a star-shaped physical wiring setup, with a token-passing access protocol. Centralized wiring closets in the cabling system are well suited to use of optical fibers.*





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applied and workable solutions found.

One successful solution is embodied in the Fiber Optic Net/One network being sold by Ungermann-Bass Inc. The underlying Net 10 optical transmission system, developed for Ungermann-Bass by the FiberLAN Division of Siecor Corporation, uses a cabling setup similar to IBM's in that a star-like formation of cables is used to connect devices on the network with a central wiring point, called the Star Wiring Center (SWC). The SWC offers flexibility in that the individual optical fibers may be interconnected in various ways, but the Ethernet-compatible arrangement requires a passive star coupler that lets the data-bearing light propagate throughout the network (see figure 4). The CSMA/CD access control is assisted by an active collision-detection-determination module. (See the text box "Driving the Fiber-Optic Ethernet Bus" on page 198.) Net/One can serve as a self-sufficient network or be connected through a repeater to an existing metallic Ethernet system.

Other network topologies besides the three just described have been suggested. Canstar Communications Ltd. of Toronto developed a dual-rooted tree topology for its Hubnet. And a group at Hewlett-Packard has proposed a topology called Anarchy, in which nodes are connected by arbitrary bidirectional point-to-point links (some ingenious software has also been proposed to sort out the routing of data traffic). Especially fault-tolerant schemes with multiple propagation paths include the FOREMAN design, which uses a four-way optical Y-coupler on each node, and the Discobus, in which several small star couplers are placed around the network. Perhaps further development will some day bring one of these, or other new ideas, into common acceptance.

Possibilities for the Future

Most computer local networks that offer use of fiber-optic cables allow some intermixing with conventional copper wiring because the interface

equipment needed for fiber-optic cables is still somewhat more costly for short distances and noncritical links. Net/One, for example, is priced about 20 to 30 percent higher than an equivalent baseband coaxial-cable system (a configuration with 200 ports would cost about $135,000). But the day may soon come when costs are brought down even further, and we may yet see hair-thin threads of glass begin to replace the venerable copper wire.

As the technology of photonics begins to catch up with electronics, integrated electro-optics may begin to provide completely optical amplifiers and logic gates, which would open up whole new realms of applications.

And widespread use of fiber-optic data links could have unexpected side effects. For instance, current computer architectures are developed with the assumption that input/output (I/O) operations will be slower than computation. But if the computer is connected via a wide-bandwidth optical connection, the I/O channel might be able to outrun the processor. If this traditional bottleneck suddenly opens up, we can look for the appearance of new and exciting ideas in building computers. ■

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BY PAUL A. NILSON

ALGORITHMS FOR A VARIABLE-PRECISION CALCULATOR

A pseudocode is used to describe the logic behind the algorithms

I developed the algorithms described here in the process of building a variable-precision calculator, which is now an integral part of a commercial spreadsheet package. I believe the material covered in this article will be valuable to people who need to perform decimal computations on large numbers.

I have a 68000-based microprocessor running a UNIX operating system with C as the main programming language. Using my version of C on the 68000, I can represent numbers as integers (16 bits) or long integers (32 bits). I have no floating-point arithmetic package. Because 32 bits limits me to nondecimal numbers with a range of −2,147,483,648 to +2,147,483,647, I needed the capacity to handle more digits and the decimal point. I thought, "How many digits are enough?"

I had only two routes to follow. The first was to pick a number (perhaps 100 digits) and develop fixed-precision algorithms using that as a base. The other approach was to let users specify what precision they needed and develop the necessary algorithms to support variable precision. I chose the second approach because the algorithms for a variable-precision calculator are really not much more complicated than those for fixed-precision calculators, and because they do not have the internal string space overhead common to fixed-precision calculators.

I gave considerable thought to computation speed. Using division as an example, I am able to divide a 40-digit number by an 8-digit number to 100 places of accuracy in 71 milliseconds (ms). Considering that I am dealing with numbers represented as digits within character strings, that is a fairly quick computation. If I were to code the calculator in assembly language it would speed it up even more.

PREPROCESSING

The calculator is set up with virtually no internal string space. The user routine that calls the calculator defines within itself three character arrays and passes pointers to those arrays to the calculator. Two of these arrays (first and second) hold the operands while the third array (results) holds the results from the computation. The arrays are defined externally to the calculator so that a user can have the flexibility of defining only as much string space as is necessary, based on the precision of the computation. The user routine also passes to the calculator an integer that defines the precision of the computation and a character (+, −, *, /) to indicate the operand. Decimal points, signs, and leading or trailing blanks can be used in the number strings. The number strings (first and second) are unmodified by the calculator.

Upon being called, the first thing the calculator routine does is establish a set of integers related to each of the number strings. These integers point to the first digit, the last digit, the

(continued)

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decimal point, and the current position within the number string. Using the first (addition) operand as an example, the integers are represented as *f*head, *f*tail, *f*point, and *f*current. Figure 1 shows the results of pointing to the fourth character position in the first array. The second and results number strings have similar integers, and their variable names start with an *s* or *r*, respectively.

(The algorithms presented here are written in a pseudocode. This code is not a real language; it merely serves as a shorthand notation to describe the logic of the algorithms.)

ADDITION

Addition is a snap. All you need to do is determine which of the two operands has the longest tail following the decimal (i.e., *f*tail-*f*point vs. *s*tail-*s*point). You then place the current pointers for both numbers the same distance to the right of the respective decimals and proceed from the right to the left, adding the corresponding digits of both numbers and bringing forward a carry. If a number does not have a digit for that position, then 0 is assumed (see figure 2).

To handle cases in which the return value array is not long enough to hold all the digits resulting from the addition, shift the digits right 1 byte each time a new digit is computed to produce a full return string. You can do this as long as there is some tail left after the decimal point. If you find that a right shift will destroy digits to the left of the decimal, an error should be returned. Note also that an addition of two numbers with different signs is really a subtraction and should be handled as such.

```
Array position   0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6
        first =    + 1 2 3 . 4

fhead    = 2       fhead digit    = 1
ftail    = 6       ftail digit    = 4
fpoint   = 5       fpoint digit   = .
fcurrent = 4       fcurrent digit = 3
```

Figure 1: *An example of the pseudocode labeling.*

```
Addition Example

         1     2     3  .  4
  +            5     6  .  7     8
       1+0   2+5   3+6   4+7   0+8
  0      0     1     1     0     0      Carry
  0      1     8     0  .  1     8

Addition Pseudocode
length   = ftail - fpoint or stail - spoint; (whichever is longer)
fcurrent = fpoint + length;
scurrent = spoint + length;
rcurrent = rtail;
carry    = 0;

while (( fcurrent >= head ) or ( scurrent >= shead ))
{
     rcurrent digit = fcurrent digit + scurrent digit + carry;
     if ( rcurrent digit >= 10 )
     {
          rcurrent digit = rcurrent digit - 10;
          carry = 1;

     }
     else
     {
          carry = 0;
     }
     decrement fcurrent, scurrent, and rcurrent;
}
```

Figure 2: *Addition algorithm example and pseudocode.*

SUBTRACTION

Subtraction, like addition, is very easy. Once again, we work from the right to the left, bringing along a borrow (see figure 3). Note that the subtraction of two numbers with different signs is really an addition and should be handled as such. Note also that a smaller number always is subtracted from a larger number, with the appropriate sign affixed. This eliminates the need to worry about complement arithmetic while performing the algorithm.

MULTIPLICATION

With multiplication, things start to get interesting. Once again, the action is from right to left and includes bringing along a carry. In multiplication and division you do not need to worry about the length of the longest tail. The computations are independent of decimal-point location (see figure 4). The final position of the decimal in the array results is determined after the computation is complete.

To multiply, all you need is to define two loops. The inner loop carries over the number of digits of the second operand (in this case, four: the digits 5, 6, 7, and 8). The outer loop carries over the sum of the number of digits in the two operands (in this case, eight). Once again, the digits in the return string must be shifted to the

(continued)


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right if there is not enough room to hold all the digits returned from the multiplication. If a shift will result in loss of digits to the left of the decimal, an error should be returned from the multiplication.

The integer example in figure 3 works for any two numbers, but it involves a lot of multiplications. In certain cases, things can be done to speed up the multiplication. Because I can represent any number with nine or fewer digits as a long integer, I can take advantage of that fact. If either first or second can be represented by eight digits, I can convert it to a long integer and multiply it as a whole by each character of the other number, obtaining a number that will always be nine digits or less. This eliminates the inner loop in the multiplication and speeds up the algorithm considerably. Figure 3 also shows the results of converting the second operand (5, 6, 7, 8) to a long integer.

As can be seen, the algorithm using long integers requires far fewer multiplications than the one using characters. If, however, neither number is a candidate for a long-integer operation, then an approach using character manipulation must be used. There is a speed advantage in the character algorithm if the first operand is the longer number, however.

DIVISION

Division is totally different from the other three operands. While addition, subtraction, and multiplication are straightforward algorithms that work from the right to the left, division is a process of successive approximations that works from left to right (see figure 5).

As you learned in grammar school, the process for finding each digit in the quotient involves making a guess for the digit, multiplying the digit by the divisor, and subtracting the result of the multiplication from the remainder of the previous process, remembering to bring down either a 0 or a digit (depending on what's left in the dividend). Because a computer can't guess at a trial digit, what is generally done is a series of trials for each digit. First, a 1 is tried as a target digit in the quotient. If the remainder is negative, then 0 is the proper digit for that position in the quotient. If the remainder is positive, then 2 is tried. This continues until the remainder turns negative, at which time the $n-1$ digit is placed in the quotient. This approach results in about five trials for each digit returned to the quotient.

My approach is a little different. While I first try the digit 1, I save the remainder and divide that by the divisor to determine what the actual digit should be. In general, only one trial per digit is necessary with this approach.

As shown in the long-integer example in figure 5, I start out by multiplying the second by a 1 to get a product. I then subtract the product from the first and look at the remainder. In the first four tries, the remainder was a negative number, which implied that 1 was too big and that 0 should be used in its place. On the fifth try, I got a nonzero remainder (+6662). Dividing this remainder by the second (+5678) yields a factor of 1. Adding this factor to the trial digit (1) shows that the actual digit in the results array should have been 2. This number is then placed in the results array at the fifth position to compute the sixth position.

As in multiplication, there are two cases to consider for division. If the number of significant digits in second is less than or equal to eight, you can use a long-integer algorithm (in which the divisor is placed into a long variable) and call a routine that will use the long-integer algorithm. If, however, the number of digits in the divisor is too large to let it be placed into a long-integer algorithm, you must call a character-based algorithm. This

(continued)

Subtraction Example

	1	2	3 .	4		First
−		5	6 .	7	8	Second
	1 − 0	2 − 5	3 − 6	4 − 7	0 − 8	(note: 0 − 8 < = = > 10 − 8 borrow 1)
0	− 1	− 1	− 1	− 1	0	Borrow
0	0	6	6 .	6	2	Results

Subtraction Pseudocode

```
length   = ftail − fpoint or stail − spoint; (whichever is longer)
fcurrent = fpoint + length;
scurrent = spoint + length;
rcurrent = rtail;
borrow   = 0;

while (( fcurrent > = head ) or ( scurrent > = shead ))
{
      rcurrent digit = fcurrent digit − scurrent digit − borrow;
      if ( rcurrent digit < 0 )
      {
           rcurrent digit = rcurrent digit + 10;
           borrow = 1;

      }
      else
      {
           borrow = 0;
      }
      decrement fcurrent, scurrent, and rcurrent;
}
```

Figure 3: *Subtraction algorithm example and pseudocode.*

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algorithm also will do the preceding computation, although not nearly as quickly as the long-integer algorithm.

As an example of a division using the character algorithm, consider for a moment the last case in the long-integer example, in which 000021731 is multiplied by 5678 and then subtracted from 123400000. The specific purpose of that exercise is to produce a remainder. Because multiplication and subtraction work from the right to the left, you also can develop each digit in the remainder from the right to the left by doing the multiplication and subtraction simultaneously.

The character algorithm works from right to left, developing each digit in the remainder as it works its way to the left. As should be clear from this example, the character algorithm involves many more multiplications and subtractions than the long-integer algorithm. In fact, the loops nest three deep with the character algorithm and only one deep with the long-integer

Multiplication Example (integer)

				1	2	3	4	First
			×	5	6	7	8	Second
				9	8	7	2	
			8	6	3	8		
		7	4	0	4			
	6	1	7	0				
	7	0	0	6	6	5	2	Results

Example (long integer)

				1	2	3	4	First
×				5	6	7	8	Second
5678×0	5678×0	5678×0	5678×1	5678×2	5678×3	5678×4	
0	0	0	5678	11356	17034	22712	Product
7	70	700	1328	1930	2271	0	Carry
7	0	0	6	6	5	2	Results

Example (character)

				1	2	3	4	First
×				5	6	7	8	Second
0×8	0×8	0×8	0×8	1×8	2×8	3×8	4×8	
0×7	0×7	0×7	1×7	2×7	3×7	4×7	0×7	
0×6	0×6	1×6	2×6	3×6	4×6	0×6	0×6	
0×5	1×5	2×5	3×5	4×5	0×5	0×5	0×5	
0	0	0	0	8	16	24	32	
0	0	0	7	14	21	28	0	
0	0	6	12	18	24	0	0	
0	5	10	15	20	0	0	0	
0	5	16	34	60	61	52	32	Product
0	2	4	6	6	5	3	0	Carry
0	7	0	0	6	6	5	2	Results

Figure 4: *Multiplication algorithm examples and pseudocode.*

algorithm. The character algorithm does have one saving grace, though: it works for any number of any size.

In using the character algorithm, a very important point to consider is the handling of the remainder. The character routine is called only because the divisor is too big to fit into a long integer. This means that the remainder also will be too big to fit into a long integer. In this case, as the remainder is developed, the first eight digits of the remainder are stored in an array. When it is time to figure the factor, the remainder from the array and the first eight digits of the divisor (second) are moved to a long-integer algorithm and divided one by the other to figure the factor. This usually gives satisfactory results, enabling the correct factor to be predicted accurately. Consider, though, the case where the remainder is very nearly an exact multiple of the divisor. While this doesn't happen very often,

(continued)

Multiplication Pseudocode (character algorithm)

```
flength = ftail - fhead + 1;        ( First's length )
slength = stail - shead + 1;        ( Second's length )
tlength = slength + flength;        ( total length )
rcurrent = rtail;                   ( start at the right and work left )
carry = 0;
offset = 0;

while ( offset < tlength )
{
      product = carry;
      j = 0;
      while ( j < slength )
      {
            scurrent = stail - j;
            fcurrent = ftail + j - offset;
            product = product + fcurrent digit × scurrent digit;
            increment j;
      }
      rcurrent digit = product mod 10;
      carry = ( product - rcurrent digit ) / 10;
      increment offset;
      decrement rcurrent;
}
```

Multiplication Pseudocode (long-integer algorithm)

```
flength = ftail - fhead + 1;        ( First's length )
slength = stail - shead + 1;        ( Second's length )
tlength = slength + flength;        ( total length )
rcurrent = rtail;                   ( start at the right and work left )
slong = Second as a long integer
carry = 0;
offset = 0;

while ( offset < tlength )
{
      product = carry;
      fcurrent = ftail - offset;
      product = product + fcurrent digit × slong;
      rcurrent digit = product mod 10;
      carry = ( product - rcurrent digit ) / 10;
      increment offset;
      decrement rcurrent; )
}
```

Division Example

```
                        0   0   0   0   2 . 1   7   3   3    Results
Second  5  6  7 . 8  |  1   2   3   4   0                    First
                     -  1   1   3   5   6                    Product
                                9   8   4     0              Remainder
                            -   5   6   7     8              Product
                                4   1   6     2   0          Remainder
                            -   3   9   7     4   6          .
                                    1   8     7   4   0      .
                                -   1   7     0   3   4      .
                                        1     7   0   6   0
                                    -   1     7   0   3   4
                                                      2   6  etc.
```

Example (long integer)

Trial Results	Second	Trial Product	First	Remainder	Process	Actual Results
1	× 5678 =	5678 −	1 ==>	− 5677		−1+1 = 0
01	× 5678 =	5678 −	12 ==>	− 5666		−1+1 = 0
001	× 5678 =	5678 −	123 ==>	− 5555		−1+1 = 0
0001	× 5678 =	5678 −	1234 ==>	− 4444		−1+1 = 0
00001	× 5678 =	5678 −	12340 ==>	+ 6662	/ 5678 =	1+1 = 2
000021	× 5678 =	119238 −	123400 ==>	+ 4162	/ 5678 =	0+1 = 1
0000211	× 5678 =	1198058 −	1234000 ==>	+35942	/ 5678 =	6+1 = 7
00002171	× 5678 =	12326938 −	12340000 ==>	+13062	/ 5678 =	2+1 = 3
000021731	× 5678 =	123388618 −	123400000 ==>	+11382	/ 5678 =	2+1 = 3
0000217331		etc.				

Example (character)

0	0	0	0	2	1	7	3	1	Results
×					5	6	7	8	Second
0×8	0×8	0×8	0×8	2×8	1×8	7×8	3×8	1×8	Multiply
0×7	0×7	0×7	2×7	1×7	7×7	3×7	1×7	0×7	
0×6	0×6	2×6	1×6	7×6	3×6	1×6	0×6	0×6	
0×6	2×5	1×5	7×5	3×5	1×5	0×5	0×5	0×5	
0	0	0	0	16	8	56	24	8	
0	0	0	14	7	49	21	7	0	
0	0	12	6	42	18	6	0	0	
0	10	5	35	15	5	0	0	0	
0	10	17	55	80	80	83	31	8	
1	2	6	8	8	8	3	0	0	Carry
1	2	3	3	8	8	6	1	8	Product
									Subtract
1	2	3	4	0	0	0	0	0	First
− 1	2	3	3	8	8	6	1	8	Product
1−1	2−2	3−3	4−3	0−8	0−8	0−6	0−1	0−8	
0	0	0	−1	−1	−1	−1	−1	0	Borrow
0	0	0	0	1	1	3	8	2	Remainder

Division Pseudocode (long-integer algorithm)

```
remainder = 0;
rcurrent = rhead;
slong = second in a long variable;

while ( rcurrent <= rtail )
{
     rcurrent digit = 1;                                   ( trial digit )
     rlength = current length of the results string;
     fcurrent = fhead + rlength - 1;
     dividend = remainder × 10 + fcurrent digit;           ( drop next digit )

     rcurrent digit = dividend / slong;                    ( divide )
     remainder = dividend - rcurrent digit × slong;        ( get remainder )
     dividend = remainder;                                 ( set up next pass )
     increment rcurrent;
}
```

Figure 5: *Division algorithm examples and pseudocode.*

CALCULATOR ALGORITHMS

Division Pseudocode (character algorithm)

```
remainder = 0;
rcurrent = rhead ;

while ( rcurrent <= rtail )
{
    rcurrent digit = 1;                                  ( trial digit )
    flength = ftail - fhead + 1;
    slength = stail - shead + 1;
    factor = carry = borrow = offset = 0;

    while ( offset < tlength )
    {
                                                         ( multiply )
        product = carry;
        j = 0
        while ( j < slength )
        {
            scurrent = stail - j;
            fcurrent = ftail + j - offset;
            product = product + fcurrent digit × scurrent digit;
            increment j;
        }
        rcurrent digit = product mod 10;
        rcarry = ( product - rcurrent digit ) / 10;

                                                         ( subtract )
        remainder digit = fcurrent digit - rcurrent digit - borrow;
        if ( remainder digit < 0 )
        {
            remainder digit = remainder digit + 10;
            borrow = 1;
        }
        else
        {
            borrow = 0
        }
        add remainder digit to remainder array;
}
                                                         ( handle remainder )
        rlong = convert remainder array to a long integer;   ( eight digits )
        slong = convert Second to a long integer;            ( eight digits )
        factor = rlong / slong;
        if ( factor >= 10 )
        {
            increment ( rcurrent - 1 ) digit;
            try rcurrent again;
        }

        if ( factor × ( divisor + 1 ) >= remainder )
        {
            rcurrent digit = factor;
        }
        else
        {
            rcurrent digit = factor + 1;
        }
        increment rcurrent;
}
```

it can, in certain circumstances, make things difficult, as shown in figure 6a.

As shown, division of the actual numbers results in a quotient of 2, while taking only the first eight digits results in a quotient of 3. To handle this, the factor is checked each time it's developed. If 1 is added to the divisor and the sum multiplied by the factor, the product can be compared with the remainder (figure 6b).

Generally, the product should be less than the remainder. If it is greater than or equal to the remainder, you cannot be absolutely sure that a factor of 3 is correct. Therefore, you must assume the worst case and decrement the factor by 1 and use that value to predict the actual digit. In this case, you would assume that the factor of 2 was correct. It could be, though, that 3 was the correct digit to use; this will be discovered on the next pass through the character routine when the factor produced is greater than 9. At that time, you must go back and increment by 1 the actual digit used in the previous case, taking care to handle strings of 9s correctly (e.g., 399 + 1 = 400) and tell the division routine to call the character routine again for the current digit. What all this means is that in this special case you will at worst have to make two trials to get a given digit for the result. Generally, though, one trial is sufficient.

(6a)

	Remainder		Divisor		Factor
Actual numbers	370370365	/	123456789	=	2
First eight digits	37037036	/	12345678	=	3

(6b)

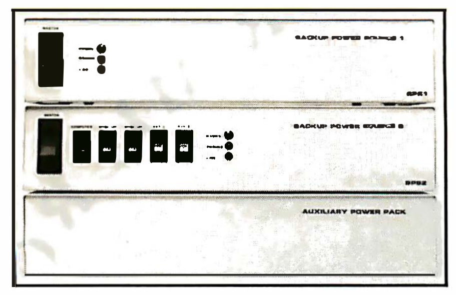
Divisor + 1		Factor		Product		Remainder
(12345678 + 1)	×	3	=	37037037	>=	37037036

Figure 6: *Comparison of factor-determining approaches: actual numbers vs. the first eight digits (a) and comparing the product and the remainder (b).*

SUMMARY

In this article, I've described addition, subtraction, multiplication, and division algorithmic approaches used in a commercial spreadsheet. The logic behind the algorithms is described using a pseudocode—not an actual programming language. ■

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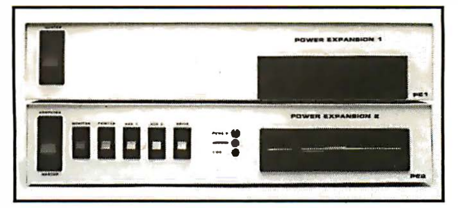
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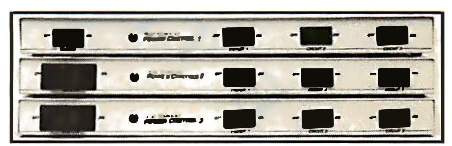
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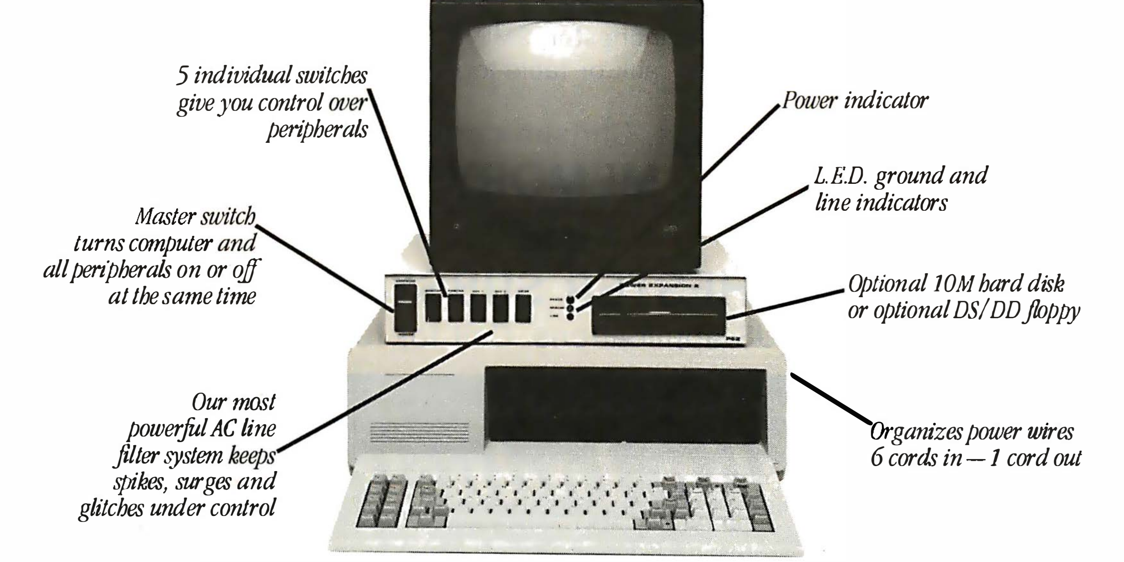
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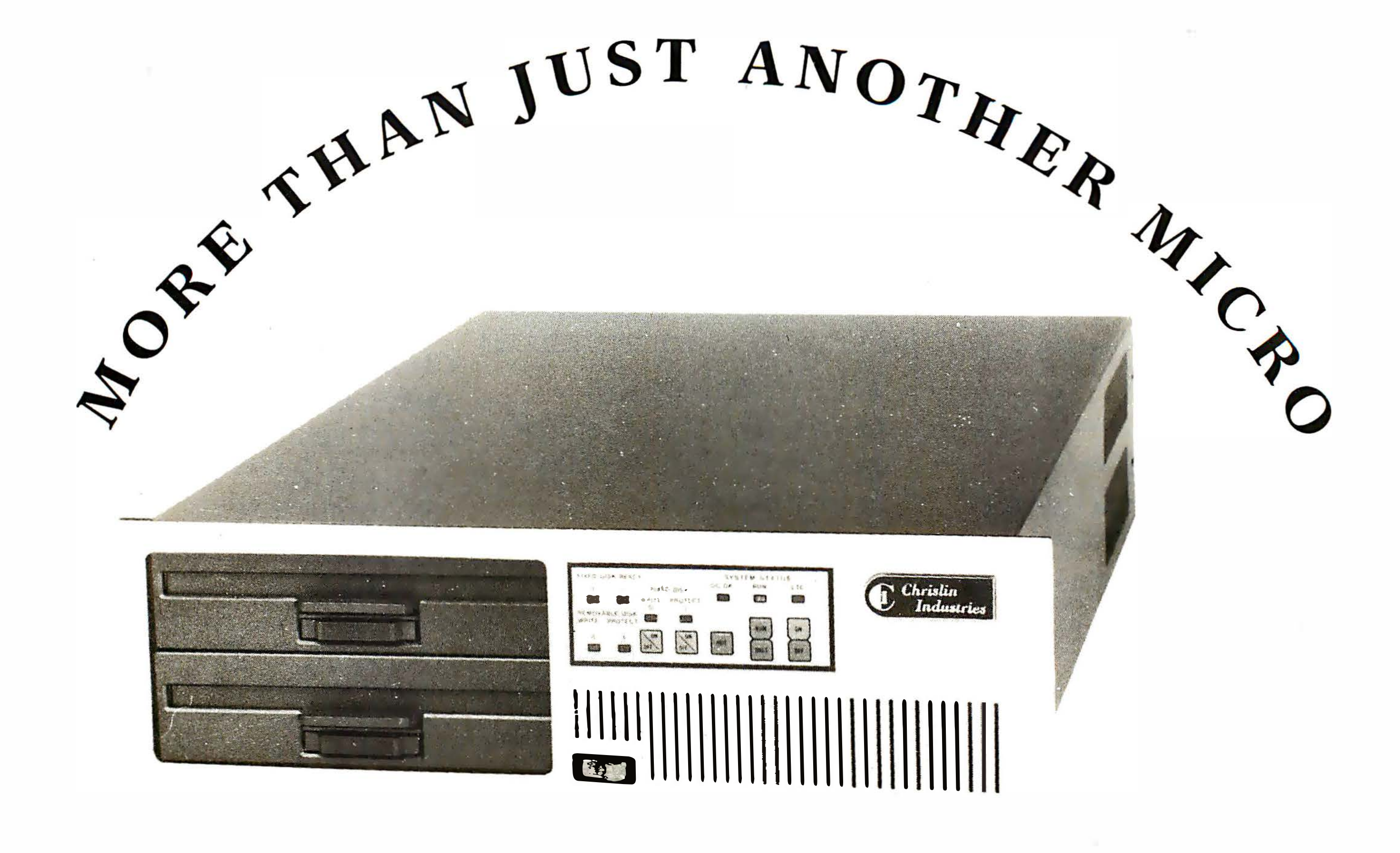
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Inquiry 54

BY VINCE BANES

AUDIO-FREQUENCY ANALYZER

Build IBM PC *accessories to analyze your stereo*

In this construction project, I'll show you how to chart the frequency response of your stereo using your computer. If high fidelity is not your cup of tea, you'll still learn how to interface a DAC (digital-to-analog converter), a VCO (voltage-controlled oscillator), and an ADC (analog-to-digital converter) to the IBM Personal Computer (PC) using a general-purpose I/O (input/output) device.

Figure 1 is a block diagram of the entire project, which is pictured in photo 1. The computer selects a control voltage for the VCO via the I/O section of the board and DAC. The sine-wave output signal from the VCO goes through the stereo's Aux (auxiliary) jack, through the stereo, and out the speaker. A microphone receives the audio energy from the speaker and feeds it through a full-wave rectifier to an ADC. The computer then reads the output of the ADC through the I/O section of the board. The system does not measure harmonic distortion; it just measures the power hitting the microphone when the system outputs a known frequency.

You could use a sine-wave generator and a very sensitive AC (alternating current) voltmeter to make these measurements. The results would be the same, but using the computer will make the tests easier and faster.

SYSTEM CONSIDERATIONS

This system measures the stereo's relative responses at different frequencies. The idea is to have the stereo sound as loud at 100 Hertz (Hz) as it does at 10,000 Hz, provided, of course, that the two signals have the same input-signal power. Therefore, we are not concerned with the exact value of the response, just how it compares with the responses at the other frequencies. Also, we want to determine what effects the room has on the stereo's sound.

The system must cover the normal audio-frequency spectrum (20 to 20,000 Hz), produce a sine wave that has less than 1 percent distortion, and have a constant power output for all frequencies. The ICL8038 waveform generator covers all of these requirements.

To reduce noise, you need shielded cables for the first stage of the input circuit. The inside of a computer is probably the worst place in the world to try to keep EMI (electromagnetic interference) noise down, but the shielding is good enough for this project. Since the noise level is constant, all of the input signals are biased equally. Thus, the difference between

(continued)

Vince Banes (2020 Sierra Dr., Lewisville, TX 75067) *is an engineer with Texas Instruments. His interests include trying to find a perfect commodity-tracking system.*

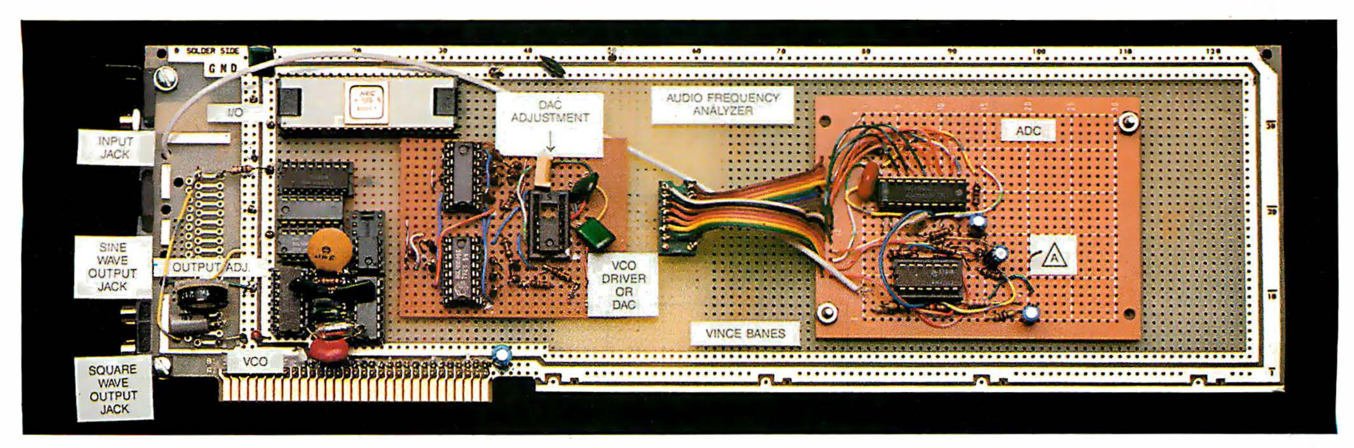


Photo 1: *Audio-frequency analyzer board.*

readings is constant. Keeping the noise less than 12 decibels (dB) below the signal being measured keeps the noise sufficently low. It is true that 12 dB sounds like a large signal-to-noise ratio, but for this application, we are looking only for deviations from the standard flat response curve. If the response differs by more than 12 dB from another signal, then an adjustment must be made to bring that frequency back to normal.

The microphone is the weakest link in the system, so try to use the best one you can find. I used a Pioneer DM-21, and the specifications on the box said that the response was flat from 20 to 12,000 Hz. The signal from this dynamic unidirectional microphone was just a few millivolts. I had to amplify it 300 times to get a usable 2-volt (V) signal.

Make sure you connect the output from the VCO to either the Aux or Tape input on the stereo. If you connect to the Phono input jacks, you will have the added response of the RIAA (Recording Industry Association of America) recording standards. Since the frequency response of a needle on a record is far from level, the record industry has changed the response curve to counteract this phenomenon. For a short experiment, after you have adjusted your stereo to a flat response, connect the output to the Phono input and observe the difference in the curves.

I could have used just a DAC and some fancy software to construct the sine wave, but that would have meant added problems writing a machine-language routine. I spent a few extra dollars for the VCO, which eliminated the problems. The VCO is simply a set-and-forget output device. The software can go off and start some other task and the VCO continues outputting the selected sine wave.

Theory of Operation

The I/O section of the board, shown in figure 2, has 24 software-controllable I/O lines. It uses the NEC 8255A-5 I/O chip. This chip was originally designed to work with the 8080 family of micros, but since the 8088 microprocessor uses many of the same I/O methods as the 8080, the 8255A will work with the higher-level chip. The 40-pin 8255A has three 8-bit I/O ports that tie directly into the system bus, with only a few decode logic chips to select the proper I/O address.

The control voltage for the VCO starts out as the output of port A on the 8255 chip and goes to an R-2R ladder network. The network acts as the DAC, "adding" the bit voltages from the 8255 into a single voltage whose value depends on the number of 1s output from the 8255. The signal from the 8255 then goes through a summing operational amplifier (op amp) to change the range of the signal from 0–3.5 V to 8.5–12 V, as measured at test point A of figure 3. This voltage controls the frequency of the VCO.

The heart of the VCO circuit is the ICL8038, which is a precision waveform generator and voltage-controlled oscillator. If you look at a spec sheet for this versatile chip, you will see that it can be used for many types of waveform generation, such as square waves, sine waves, and triangular waves. Basically, the chip needs a timing capacitor connected from pin 10

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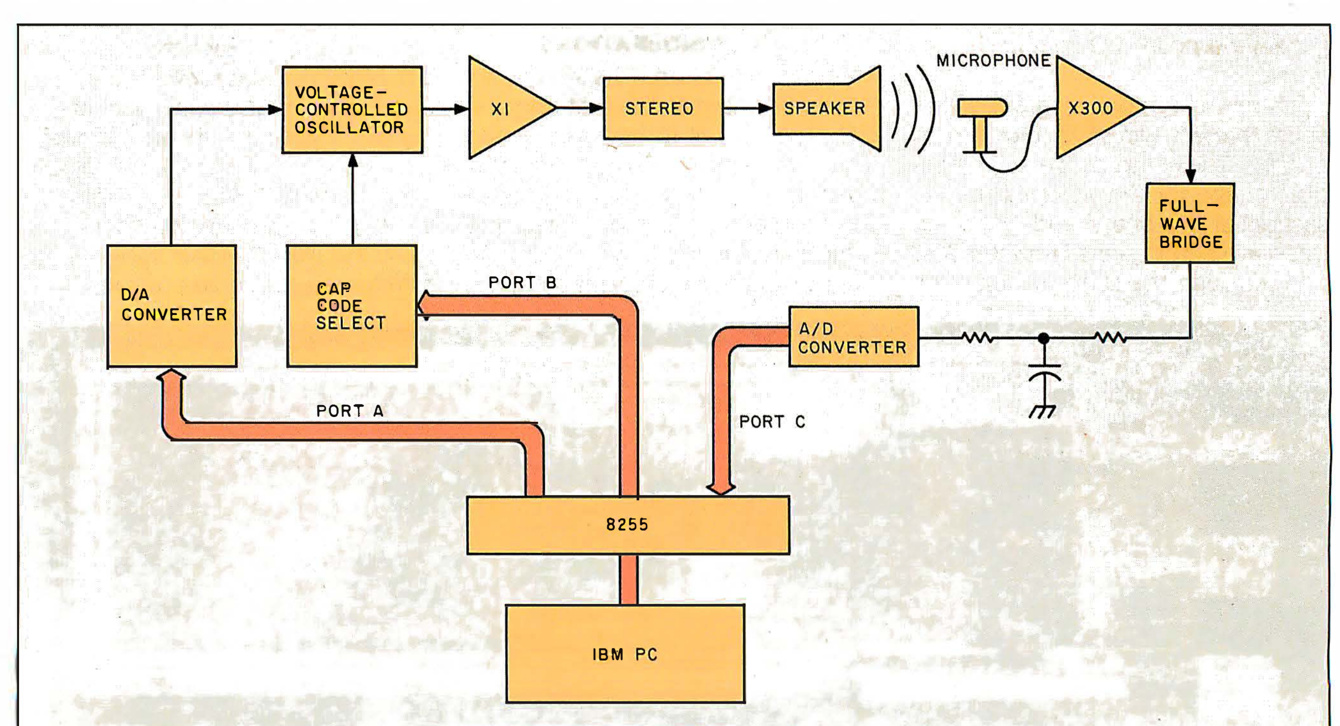
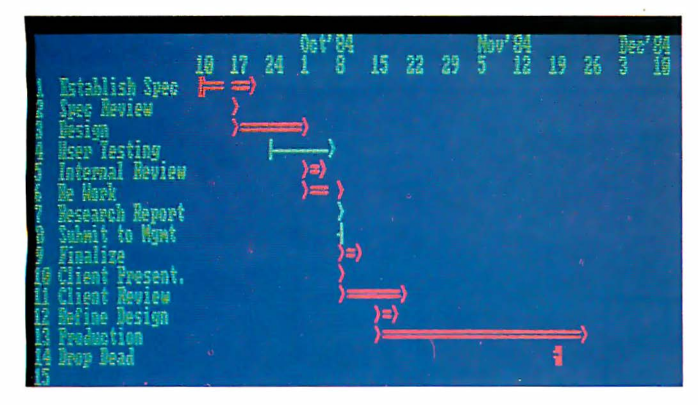


Figure 1: *System block diagram.*

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to ground to select the frequency range, and a control voltage on pin 8 to vary the frequency. The capacitor should range from 1 microfarad (μF) to 500 picofarads (pF). The control voltage must be between 8.5 and 12 V. This gives a 4-to-1 dynamic frequency range for each capacitor.

The timing capacitor is selected by an output through port B. The output transistor of a TTL (transistor-transistor logic) open-collector chip, the 7406 chip in figure 3, controls the capacitors' ground leads. When the output of the chip is OFF, one side of the capacitor is at a high impedance and therefore has no effect on the VCO. When the chip's output is ON, the capacitor is grounded and then can affect the VCO's output. This allows the computer to select the capacitor (or capacitors) needed for the desired frequency range.

The sine-wave output from the VCO has an output impedance of about 1000 ohms. This is too high to drive anything except another op amp. Thus, I've included a simple noninverting buffer amplifier to drive the stereo. By the way, only one channel of the stereo is driven at a time. During testing, the opposite channel's volume should be off.

The full-wave rectifier, shown in figure 4, converts all the negative parts of the signal to positive, because if we did the integration on the unrectified input signal, the average would work out to zero at all frequencies. By inverting the negative half of the signal, we can integrate the resulting waveform to get a voltage level that is proportional to the input power. This is the signal that is fed directly to the ADC in figure 4. Figure 4 also shows the signal before and after the rectifier. The humps of the rectifier's output may not be equal; you can adjust the DC bias on the input amplifier so that they are. But, for this project, a slight difference will not affect the results.

The ADC0804 is an 8-bit microprocessor-compatible ADC. The chip's spec sheet shows many different configurations. I've chosen the free-running mode for this circuit. If you

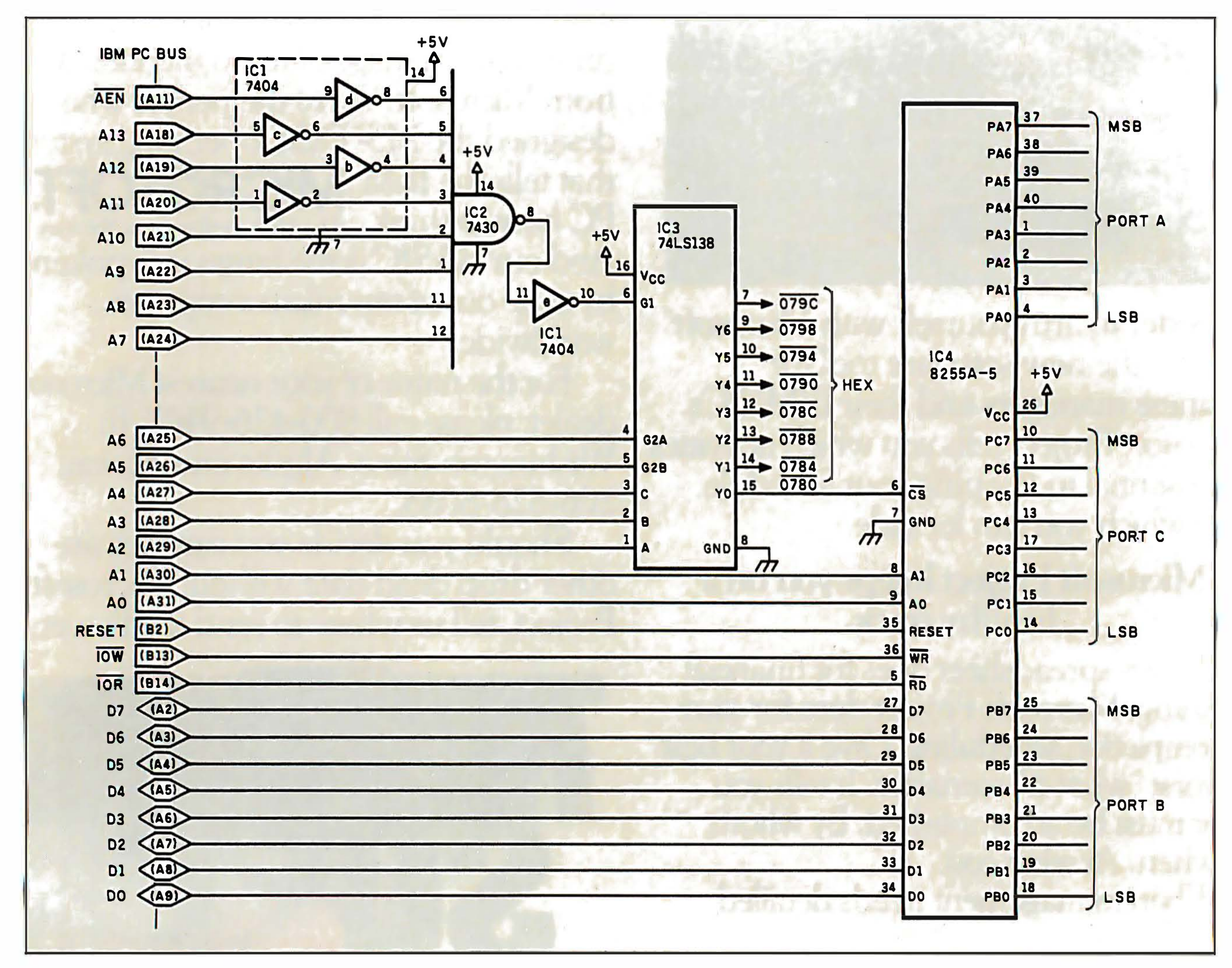


Figure 2: *Diagram of the I/O section of the board.*

are looking at this circuit as a basis for some other project, get a hold of the spec sheet to see how to connect the $V_{in}(+)$, $V_{in}(-)$, and $V_{ref}/2$ signal lines to activate the other modes. I used a resistor divider network with a large capacitor for $V_{ref}/2$. It was good enough for this application, but for other projects it should be connected to a more stable voltage source.

Since the ADC is in a free-running mode the 8255's port C is updated automatically approximately every 200 microseconds (µs). The exact update rate is determined by the value of the 150-pF capacitor and the 15K-byte resistor connected to pin 4 of the ADC0804 chip. On the other hand, if the chip were connected directly to the bus lines, then the software would have to output a "start conversion" command, wait for the chip to convert the frequency, then input the data from the converter. Therefore, in the interest of saving software, the hardware keeps restarting itself when a conversion is completed.

The chip may not start free-running when the power is first applied. To prevent this, connect the last gate from the 7406 chip to the $\overline{WR}$ and $\overline{INTR}$ lines (pins 5 and 3). At the start of the program, the software generates a 1 on the MSB (most significant bit) of port B, and then a 0 on the same line. This pulls the $\overline{WR}$ line low then high again. After the first software initialization, the $\overline{INTR}$ line goes low when the chip finishes converting. This wraps around back to the $\overline{WR}$ line and starts the chip converting the next voltage.

I/O Construction

The construction of the I/O section of the board is straightforward and has no tricky isolation requirements. The best part about this section is that the I/O lines can be accessed directly from BASIC without any special machine-language routines. The update rate in BASIC is about 15 to 25 milliseconds (ms), so if more speed is required, you have to use machine language.

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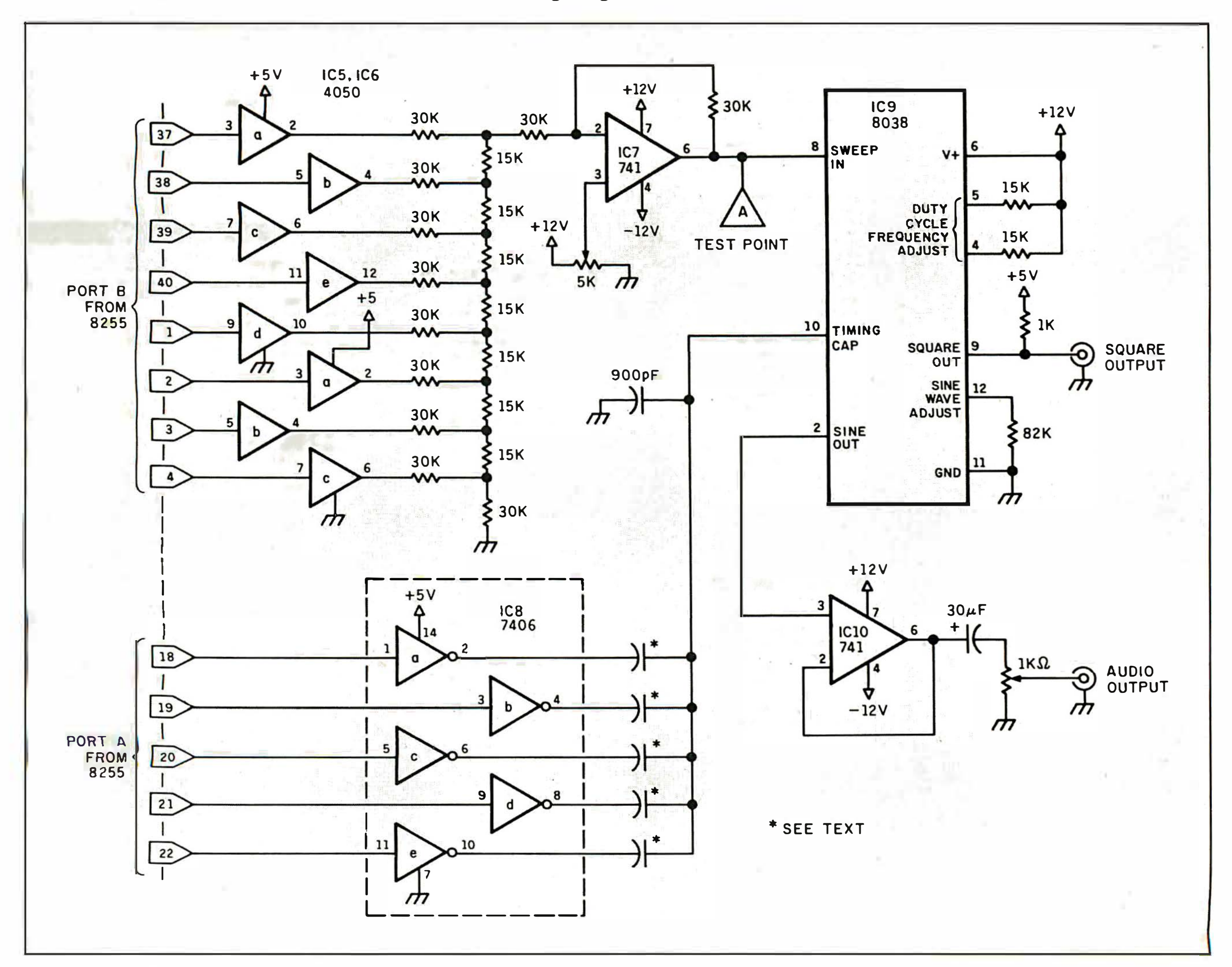


Figure 3: *Voltage-controlled oscillator and driver circuitry.*

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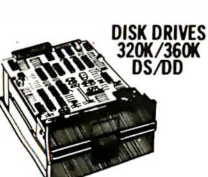


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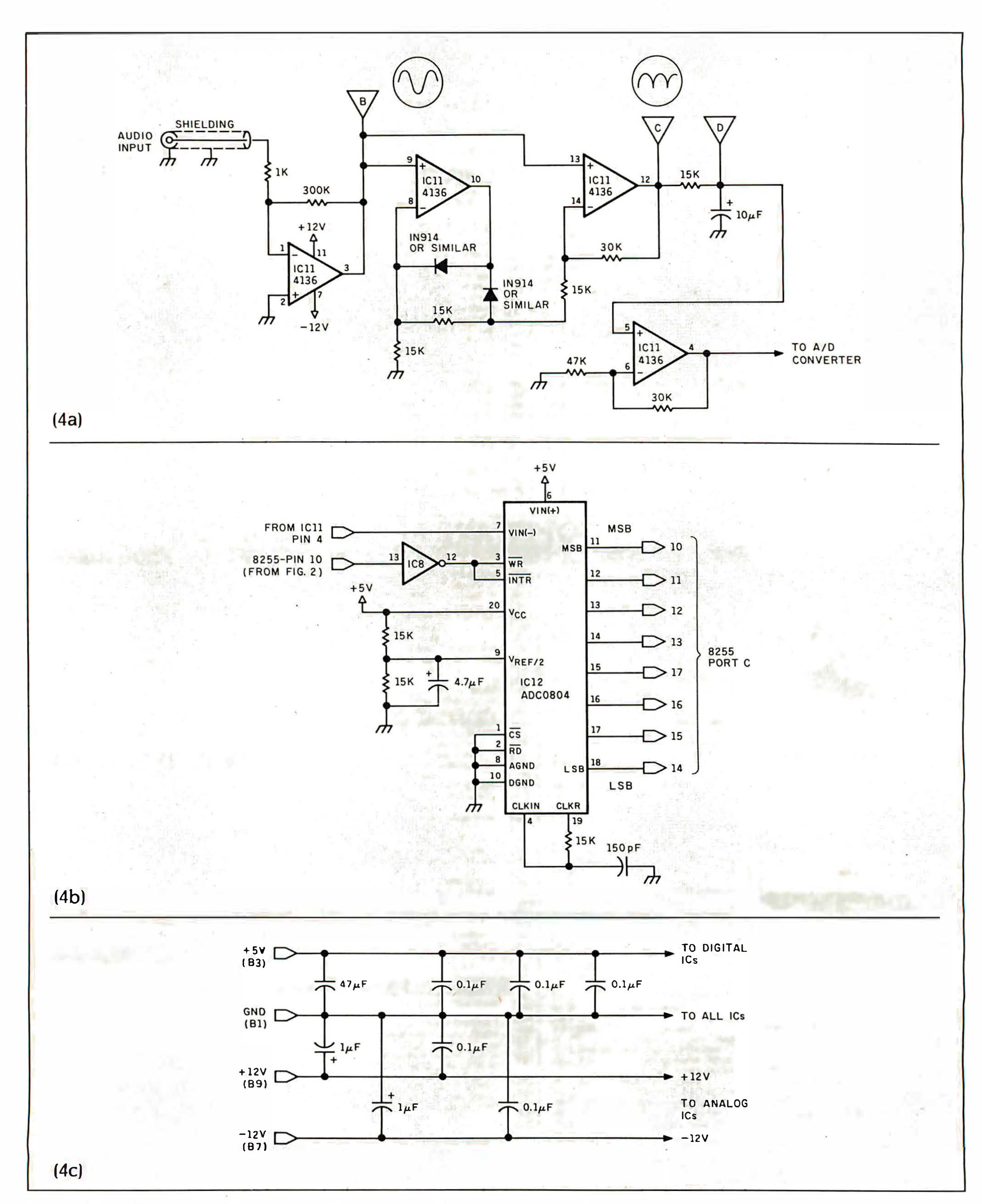


Figure 4: *Audio input and full-wave rectifier (a), ADC (b), and power connections (c).*

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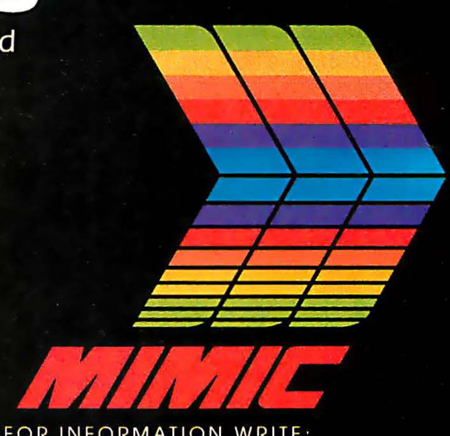
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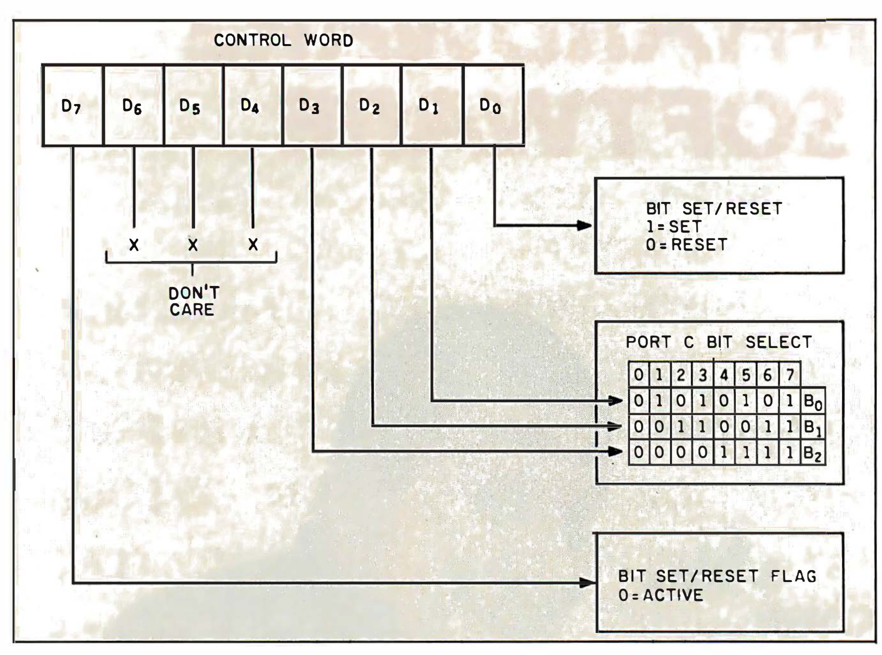


Figure 5: *Setting the port C bits of the 8255A using the control word.*

Table 1: *I/O addresses.*

Pin number	Name	I/O address (hex)
15	Y0	0780–0783
14	Y1	0784–0787
13	Y2	0788–078B
12	Y3	078C–078F
11	Y4	0790–0793
10	Y5	0794–0797
9	Y6	0798–079B
7	Y7	079C–079F

Table 2: *Control words that control the data direction of the 8255A's ports. Bits 2, 5, and 6 are 0. Bit 7 is 1.*

D_4	D_3	D_1	D_0	PORT A	PORT C (UPPER)	PORT B	PORT C (LOWER)
0	0	0	0	OUTPUT	OUTPUT	OUTPUT	OUTPUT
0	0	0	1	OUTPUT	OUTPUT	OUTPUT	INPUT
0	0	1	0	OUTPUT	OUTPUT	INPUT	OUTPUT
0	0	1	1	OUTPUT	OUTPUT	INPUT	INPUT
0	1	0	0	OUTPUT	INPUT	OUTPUT	OUTPUT
0	1	0	1	OUTPUT	INPUT	OUTPUT	INPUT
0	1	1	0	OUTPUT	INPUT	INPUT	OUTPUT
0	1	1	1	OUTPUT	INPUT	INPUT	INPUT
1	0	0	0	INPUT	OUTPUT	OUTPUT	OUTPUT
1	0	0	1	INPUT	OUTPUT	OUTPUT	INPUT
1	0	1	0	INPUT	OUTPUT	INPUT	OUTPUT
1	0	1	1	INPUT	OUTPUT	INPUT	INPUT
1	1	0	0	INPUT	INPUT	OUTPUT	OUTPUT
1	1	0	1	INPUT	INPUT	OUTPUT	INPUT
1	1	1	0	INPUT	INPUT	INPUT	OUTPUT
1	1	1	1	INPUT	INPUT	INPUT	INPUT

The 74LS138 provides eight strobe lines. Only one of these is used for the 8255. The other seven are spare and can be connected to more 8255As for even more I/O lines. These strobe lines are normally high and go low for approximately 1 μs. The I/O address for the 8255A is 0780 hexadecimal (1920 decimal). Table 1 gives the I/O addresses for the eight strobe lines from the 74LS138.

The decode logic does not use lines A14 and A15. That means that if any other part of the IBM PC uses an I/O address higher than 3FFF hexadecimal, there could be an I/O conflict. Most of the boards built to be compatible with the IBM PC and the computer itself use I/O addresses of 03FF hexadecimal or less. This puts these I/O addresses safely above the system I/O.

There are three basic software-selectable operation modes for the 8255A: Mode 0 (basic input/output), Mode 1 (strobed input/output), and Mode 2 (bidirectional bus). The chip has three separate data ports: A, B, and C. The mode selected for ports A and B can be different, but port C is configured to follow what is selected by A and B. The upper half of port C is configured with port A and the lower half of port C is configured with port B. This mixture of mode selection along with the I/O modes for each of the ports may seem confusing at first, but the following review of the main I/O operations will clear up the matter.

Port C may be written to differently from the other ports; that is, individual bits may be changed in the port without affecting the other bits of the port. The bit pattern required to either set or reset a single bit is shown in figure 5. To set bit 5 in port C to a 1, output an 11 (decimal) to the control-word register. To make bit 2 a 0, output a 4 to the control-word register.

There are four internal registers in the 8255A chip. The first three are for the three data ports and the fourth one is the control-word register that I mentioned earlier. In the configura-

(continued)

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Listing 1: *Output to all three ports.*

```
10 BASE = 1920
20 INPUT "DATA FOR PORT A";A
30 INPUT "DATA FOR PORT B";B
40 INPUT "DATA FOR PORT C";C
50 OUT BASE+3,128   :REM SET ALL LINES TO OUTPUT
60 OUT BASE,A       :REM OUTPUT TO PORT A.
70 OUT BASE+1,B     :REM OUTPUT TO PORT B.
80 OUT BASE+2,C     :REM OUTPUT TO PORT C.
90 STOP
```

Listing 2: *Input data from all ports.*

```
10 BASE = 1920
20 OUT BASE+3,128+16+8+2+1 :REM SET CONTROL WORD.
30 PRINT "DATA FROM PORT A = ";INP(BASE)
40 PRINT "DATA FROM PORT B = ";INP(BASE+1)
50 PRINT "DATA FROM PORT C = ";INP(BASE+2)
60 STOP
```

Listing 3: *Two output ports and one input port.*

```
10 BASE = 1920
20 OUT BASE=3,128+2  :REM SET CONTROL WORD
30 INPUT "DATA FOR PORT A";A
40 INPUT "DATA FOR PORT C";C
50 OUT BASE,A
60 OUT BASE+2,C
70 PRINT "DATA FROM PORT B = ";INP(BASE+1)
80 STOP
```

Listing 4: *Machine-language routine to test the* 8255A.

```
0500:0000 B080      MOV     AL,80
0500:0002 BA8307    MOV     DX,0783
0500:0005 EE        OUTB    DX
0500:0006 90        NOP
0500:0007 BA8007    MOV     DX,0780
0500:000A B0FF      MOV     AL,FF
0500:000C EE        OUTB    DX
0500:000D B000      MOV     AL,00
0500:000F EE        OUTB    DX
0500:0010 EBF8      JMPS    000A
```

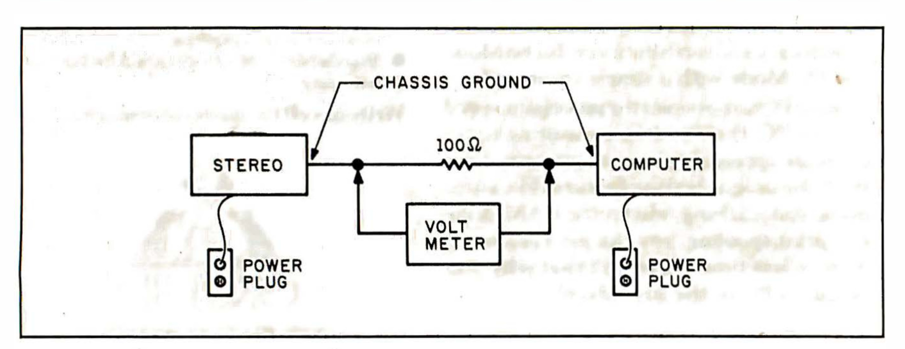


Figure 6: *Potential ground problem test configuration.*

tion given by the decode logic, port A has an I/O address of 1920 (decimal), port B has an I/O address of 1921, port C has an I/O address of 1922, and the address of the control word is 1923.

To change the direction of the ports, set the control-word register as shown in table 2. For example, to set all the ports to outputs, set the control word to 128. To make all the ports inputs, set the control word to 155. For the last example, make port A an output port, port B an input port, and port C one-half input and one-half output. This would give an output word of 128+8+2 or 138 to the mode control word.

The output pins of the 8255A can produce or sink about 1.5 milliamps. This is more than enough for most experiments. The biggest problem is if the experiment is located more than about 4 meters from the computer; the outputs might be loaded down by too much capacitance on the cables. If the experiment does require long lines, then it will be best to use line drivers and receivers. Fortunately, in this project, the lines to the DAC are short.

Software Examples

The three BASIC routines in listings 1, 2, and 3 show how to control the data on the I/O ports by using the INP and OUT commands. The first example asks the operator for three data words and then outputs them to the three ports. When the program is finished, the data is latched on the output pins. The second example makes all three ports into input ports and displays the data present on the I/O lines. The third example is just a mixture of the two. Data is output to ports A and C, and input from port B.

The machine-language routine in listing 4 produces a pulsed pattern on all pins of port A. This is useful in checking out the board during construction. Simply connect an oscilloscope probe to any of the port A pins and observe the square-wave output. The routine was produced with the DEBUG utility. Once the routine begins, the only way to stop the pro-

gram is to hit the reset switch. This example also shows the machine-language instructions needed to control the 8255A.

Before you go any further, I want to warn you about the possibility of a dangerous voltage difference between the ground of your stereo and your computer. First, connect the chassis of the two machines with a 100-ohm resistor. This is shown in figure 6. If the resistor does not get hot, then the stereo and the computer power supplies are not exchanging angry words over which side of the power line is ground. If you take a voltmeter and measure the difference between the two grounds without the resistor, you could get a 60-V reading. That is because the two power supplies are floating with respect to earth ground. The 100-ohm resistor will allow the two floating grounds to adjust themselves to each other. When the resistor is used, there should be less than a 10-V potential between the two systems. If there are more than 10 V, then you have a grounding problem that must be fixed before anything else can be done. Maybe you need to flip the stereo's power cord. But do not connect the two if there is a grounding problem.

DAC, VCO, AND ADC CONSTRUCTION

Since we want to keep some of the noise out of the system, keep the leads as short as possible. I used a mixture of wire-wrap and soldered printed-circuit board material, but you can use whatever is best for you. I built the system in sections so I could test each separately. This made it easier to find errors without subjecting the computer to my hacking. Remember to make some test points on the boards. This will help in both calibration and in testing.

DAC CALIBRATION AND TESTING

The first step in calibrating the system is to adjust the 5k-ohm potentiometer (pot) on the output amplifier of the DAC. This pot adjusts the offset of the DAC to get it into the 8.5- to 12-V range. First, set all the inputs to the 4050 chips to 0. Do this by either outputting a 0 to port A or, if the DAC is not connected to the 8255 yet, by connecting them to ground with clip leads. Then measure the output at point A of the drawing. Adjust the level of the 5k pot until the voltage is 8.4. Now bring all the inputs to the 4050s to 1. The voltage at point A should be close to 12 V. If not, go back and check for errors.

VCO CALIBRATION AND TESTING

The calibration of the output section now depends on selecting the proper values for the five capacitors used on the 8038 chip. Try to find the following five capacitors either at a store or in your junk box: 0.33 μF, 0.1 μF, 0.033 μF, 0.01 μF, and 3300 μF. You might have to connect capacitors in series or parallel to get these values. But anything close will do. As you experiment with the selection, you might be able to expand the range beyond the 20- to 20,000-Hz limits. By selecting the right capacitor, the system will work at up to 400,000 Hz.

There are 32 different combinations of capacitors. Take the five capacitors you have collected and put them in the circuit as shown in the drawing. Don't worry about which goes where, because it doesn't make a difference.

Now comes the problem of measuring the frequency. If you have access to an audio-frequency counter, just connect the counter to the square-wave output line of the VCO. Most people will probably have to use the computer to help tune the system. As you know, IBM BASIC has the SOUND command. This command will produce a tone at a particular frequency for a given length of time. The built-in speaker should generate a tone loud enough to be heard.

If you have an oscilloscope, then you can use the Lissajous figure technique to determine the frequency of the system's output. For this, first place the output from the VCO in the *x*-axis input and then connect the wire going from the computer's speaker to the *y*-axis input. Adjust the frequency from the computer's speaker with

(continued)

Listing 5: *Program to determine endpoints of the VCO ranges.*

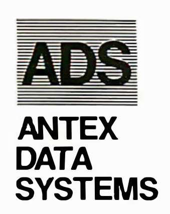
```
10 OUT 1923,128+9
20 OUT 1921,128:OUT 1921,0
30 INPUT "CAP CODE",CC
40 OUT 1920,CC
50 INPUT "FINE FREQ",FF
60 OUT 1920,FF
70 INPUT "COMPUTER FREQUENCY",F
80 SOUND F,20
90 GOTO 70
```

the SOUND command to make the display stop rolling. When the display is in the shape of a circle or something close to a circle and it does not cross itself, then the frequency of the speaker is the same as the frequency of the system. The third method is to make both the stereo and the computer's speaker sound at the same time. Then you just listen and adjust the computer speaker's tone until the two tones match. The difference between two tones going at the same time should be rather easy to detect, unless you are tone-deaf, in which case this entire system will not be of much use anyhow. The short BASIC program in listing 5 should make this process easier.

If you have the frequency counter, delete lines 70, 80, and 90. In any case, measure the frequency at the upper and lower ends of each of the 32 different capacitor-combination ranges. Make a chart of these measurements similar to the one in figure 7 and show what areas of the frequency spectrum are covered by what capacitor combination. From this chart I was able to select the capacitors needed to cover the entire audio range. The VCO response is linear over most of the control-voltage range, except for the upper and lower 10 percent of the range, which you should avoid.

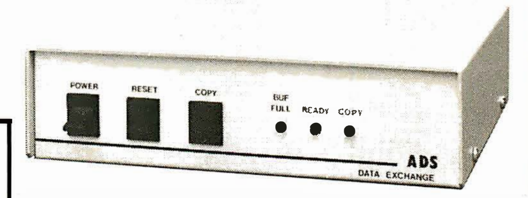
The graph in figure 8 shows the fine-frequency code versus the output frequency for one of the capacitor codes. The actual numbers are not important; the point of the graph is to show the slight nonlinearity at the ends of the control-voltage range. On

(continued)



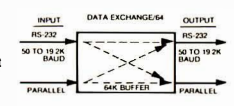
ANTEX
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ADS 8212 Data Exchange/64K Spooler



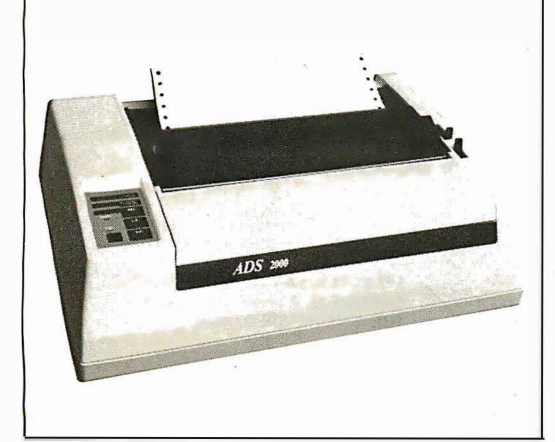
The ADS-8212 DATA EXCHANGE/64 is a computer independent interface converter and print spooler. It can be installed between virtually any computer and any peripheral. A microprocessor controls the exchange of data. Input the data in one form and the DATA EXCHANGE/64 stores it in the 64K bytes of buffer memory and then outputs it in another form to the peripheral. The DATA EXCHANGE/64 also allows the user to make multiple copies of the buffer memory.

FEATURES: RDY/BSY, Xon/Xoff or ETX/ACK for input/output



ADS 2000 DOT MATRIX PRINTER

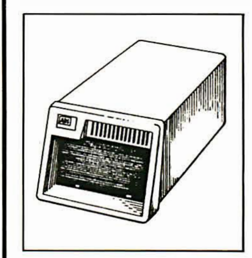
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40 CPS VERY NEAR LETTER QUALITY 17X17 DOT MATRIX



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ADS 8213 Winchester Mass Storage System – IBM PC/XT

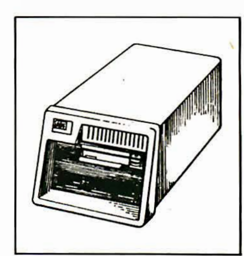


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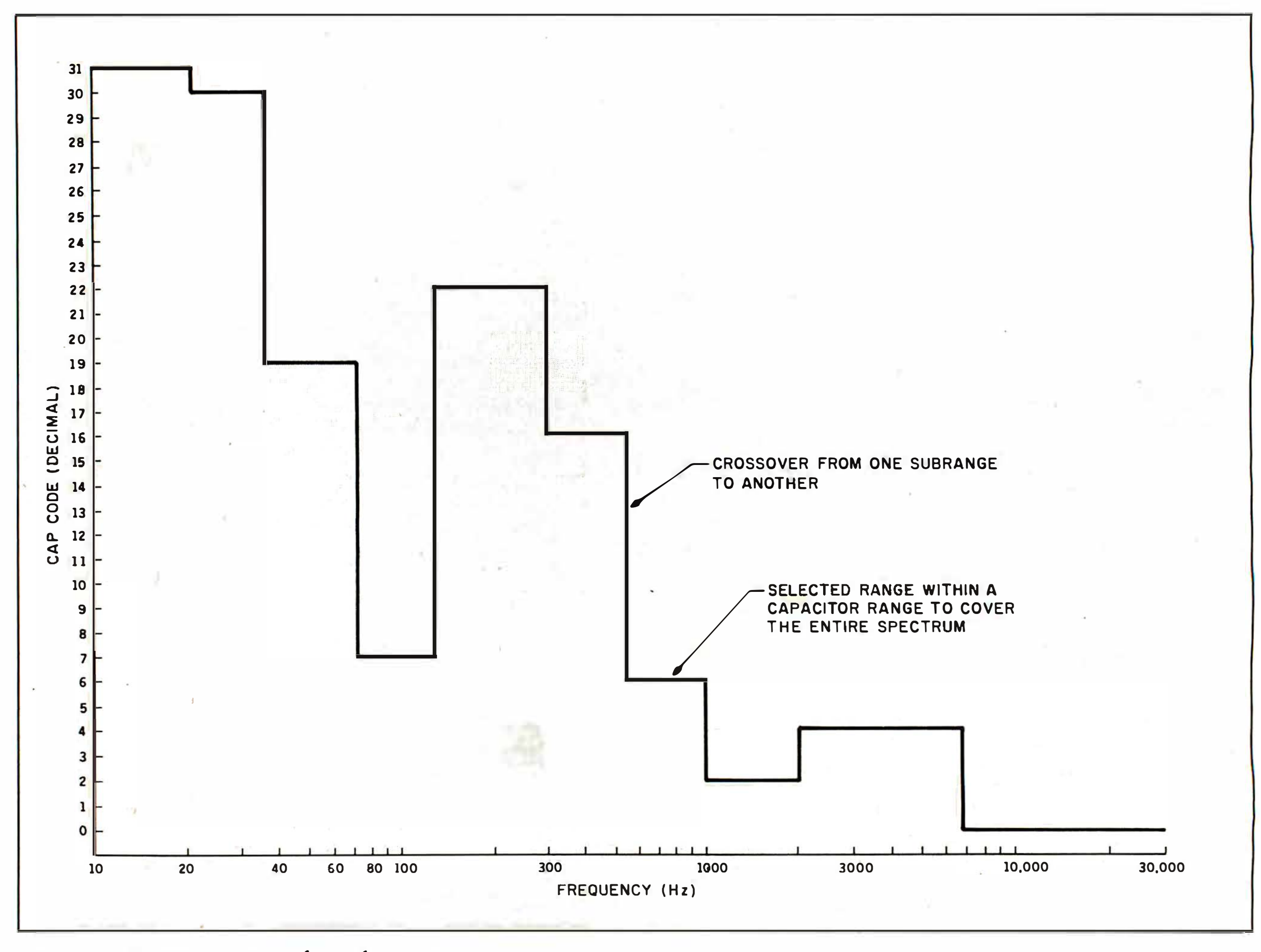


Figure 7: *Spectrum coverage by each capacitor range.*

my selection of codes, I had to use the lower end of the range twice, but I just used a different slope in the conversion equation when I was near the ends. If you study the data I used, you will see that I divided one of the ranges into three separate subranges, each of which has a different slope. Table 3 shows my selection of ranges and the codes, slopes, and starting points for each range. These values give me an accuracy of better than 1 percent over the entire audio spectrum.

The procedure I used to compute the values in the BASIC routines is this: first, take the difference between the lower and upper limits of the selected ranges. Now, try various fine-frequency codes to find the code that will produce the frequencies required for the ends of the ranges. Second, take the difference between the fine-frequency codes required to generate these frequencies. Divide the fine-frequency code delta (difference) by the frequency delta. This becomes the slope of the selected capacitor. The DATA statements have the information organized as lower-frequency limit, capacitor code, slope, and lower fine-frequency code.

The 1k pot adjusts the output level of the VCO to match the particular stereo you are testing. Most require a 200-millivolt (mV) signal for the best frequency response.

ADC Calibration and Testing

To calibrate and test the input section, use a resistor divider network similar to the one in figure 9 to reduce the voltage from the output section to about 5 mV. Feed this 5-mV signal to the input section and check that everything is okay. If you run the Sweep program in this configuration, you will see a straight line, as shown in figure 10a. (The program actually plots using plus (+) symbols. For discussion purposes, we've used a solid line in this and subsequent figures.) Just to check the theory, connect a capacitor across the input connection of the resistor network. Figure 10b shows the classic low-pass filter response. Connecting a coil produces the opposite effect.

Software

I used BASIC in these software examples because all IBM PCs and their

(continued)



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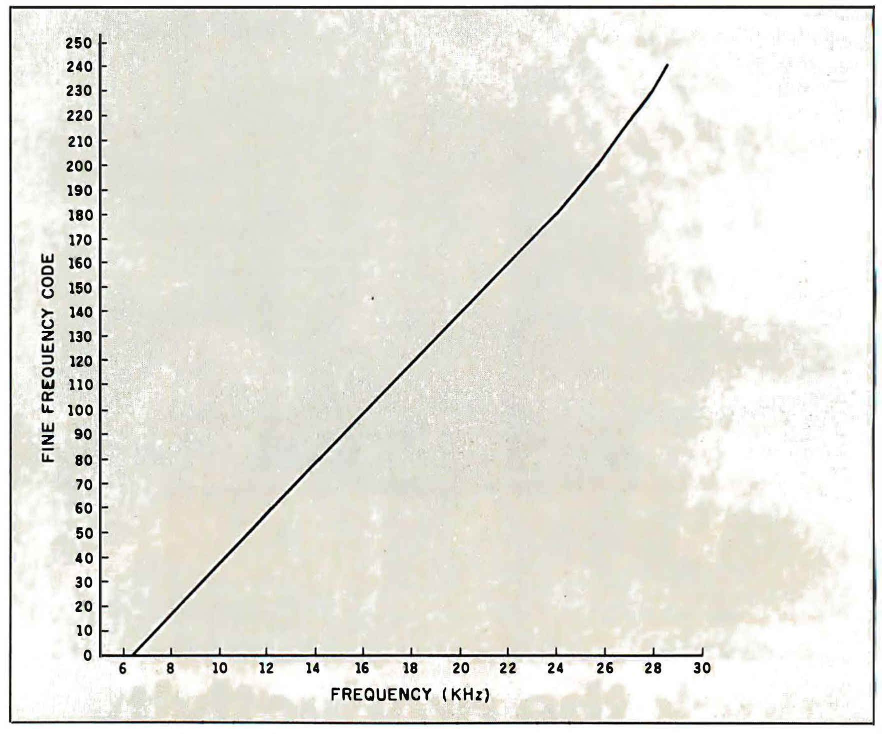


Figure 8: *Graph of fine frequency versus output frequency.*

Table 3: *Calibration data.*

Capacitor Code	Frequency Low	Frequency High	Fine Frequency Low	Fine Frequency High	Delta Freq	Delta Fine Fr	Slope
31	8	20	0	110	12	110	9.16670
30	21	35	70	95	14	25	6.78570
19	36	70	31	86	34	55	2.52940
7	70	124	90	114	54	24	2.11110
22	126	200	15	45	74	30	0.60810
22	201	300	45	59	99	14	0.59600
16	301	552	78	118	251	40	0.46990
6	553	1007	23	69	454	46	0.15210
2	1005	2002	58	118	997	60	0.11840
4	2009	3994	26	86	1985	60	0.04332
4	4001	6660	112	128	2659	16	0.04814
0	6670	7744	0	16	1074	16	0.01490
0	7785	14279	16	65	6494	49	0.01001
0	14280	30116	81	159	15836	78	0.01004

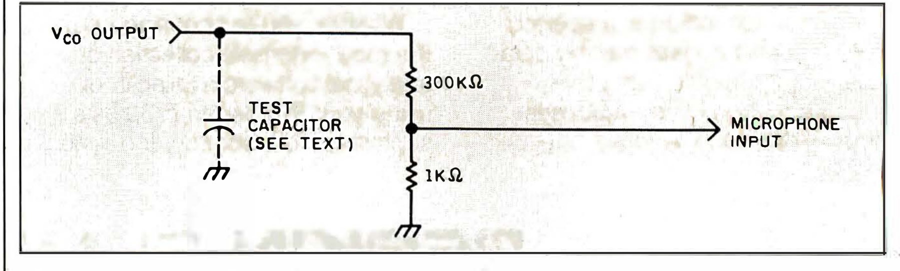


Figure 9: *Input section calibrate and test setup.*

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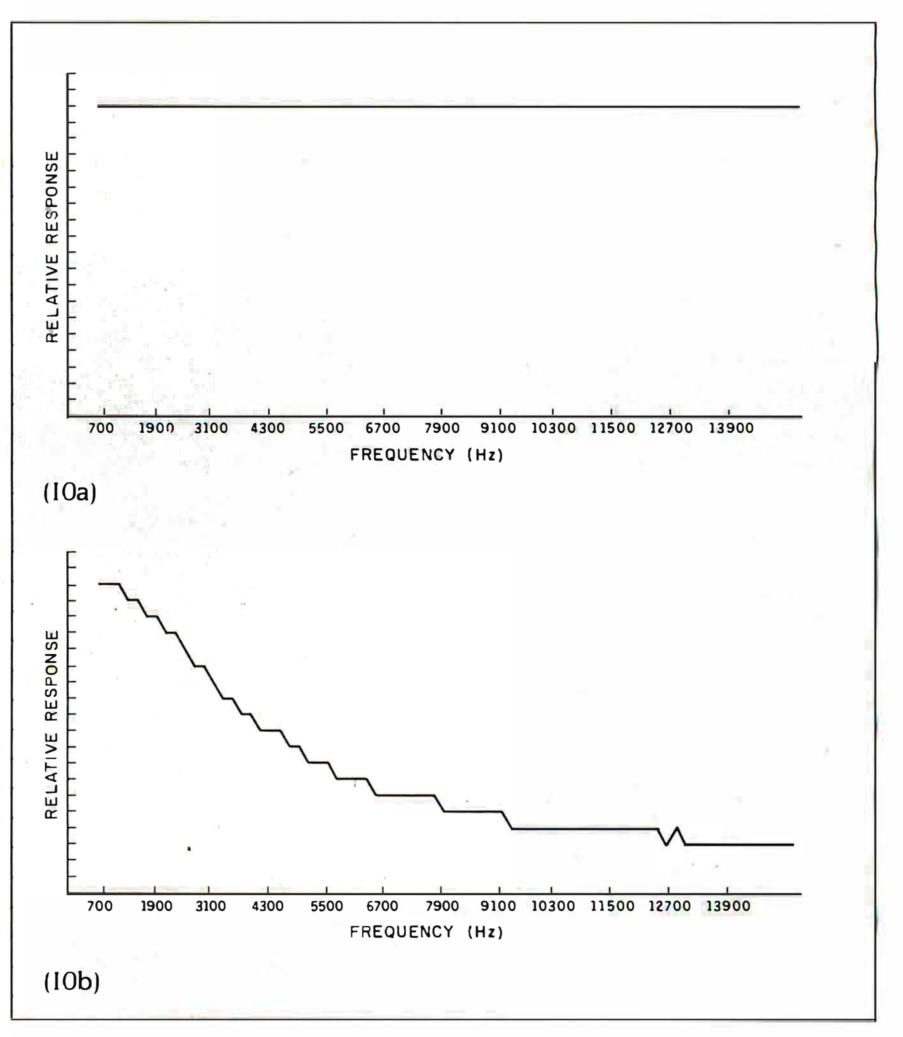


Figure 10: *Straight connection through a resistor divider network (a); 0.47μF capacitor across the input (b).*

Listing 6: BASIC *input and output routines.*

```
10 OUT 1923,137: ' SET-UP THE 8255 FOR OUTPUTS ON
   PORTS A AND B, AND INPUT ON PORT C.
20 OUT 1921,128:OUT 1921,0:' CLEAR THE FREE RUNNING MODE.
30 INPUT "RANGE CODE",RC:' INPUT THE CAPACITOR SELECT CODES.
40 OUTPUT 1921,RC:' OUTPUT THE CAP CODE TO HARDWARE.
50 INPUT "FINE FREQ CODE",FF:'INPUT THE VALUE USED
   FOR THE DAC.
60 OUTPUT 1920,FF:' SEND THE DATA TO THE HARDWARE.
70 REM NOW WASTE SOME TIME TO LET THE HARDWARE SETTLE
   TO THE CORRECT VALUE.
80 FOR I = 1 TO 200:X=X+1:NEXT
90 ADC=INP(1922):'GET THE ADC DATA FROM THE HARDWARE.
100 PRINT "RESULTS = ";ADC
```

clones have BASIC. If you want to use another language, then just convert the input and output commands to the appropriate command in the new language. If you are the type to tackle a project like this, then you should have no trouble with these examples. I expect that you will modify these listings to fit your situation.

Listing 6 shows the basic operation of the hardware without any fancy software to get in the way. It just takes the inputs from the operator and sends them directly to the VCO. It lacks the ability to convert a frequency to the proper capacitor code and fine-frequency value. The next example, the Tune program in listing 7, shows the software getting a frequency from the operator and converting it to a capacitor code and fine-frequency code. The numbers in the data statements will be different, depending on the capacitors you use in the VCO circuit and the adjustment of the 5k-ohm pot on the DAC output.

After the software checks to see if the frequency is a valid number, it searches the table for the correct VCO range for this frequency. When the computer has determined the range to use, it computes the delta between the selected frequency and the lower frequency of the band. This delta is then multiplied by the slope factor and added to the lower fine-frequency code to get the final fine-frequency code. This is just straight-line interpolation. The software then takes this fine-frequency value and sends it to the DAC. This method gives a 1 percent accuracy across the band. If you have a good frequency counter and want to get better accuracy, you can write a program that checks all the possible capacitor codes to select the one that matches the selected frequency the closest.

There are two unused output lines on the 8255 that could be connected to two more capacitors. This will allow you to provide some intermediate values. Now the software will keep looping around, inputting the results and displaying the results on the screen. When the operator hits any key, the software will accept a new frequency to tune.

The Sweep program in listing 8 is similar to the single Tune program. This time the operator gives the starting frequency and the ending fre-

(continued)

Listing 7: *The Tune program.*

```
10 '   AUDIO FREQUENCY ANALYZER          [TUNE]
20 '   ------------------------------------------------------------------------
30 '
40 CLS:OUT 1923,137:DIM FL(14),CC(14),SL(14),FCL(14)
50 OUT 1921,128:OUT 1921,0:OUT 1920,255
60 '
70 ' Read the calibration data from the DATA statements.
80 '
90 FOR I = 0 TO 14
100 READ FL(I),CC(I),SL(I),FCL(I)
110 NEXT:KEY OFF
120 LOCATE 12,20:INPUT "FREQUENCY = ";F
130 IF (F<30000) AND (F>8) THEN GOTO 170
140 LOCATE 2,25 :PRINT"BAD FREQUENCY"
150 LOCATE 12,30:PRINT"
160 GOTO 120
170 LOCATE 2,25 :PRINT"
180 '
190 ' Convert the frequency [hertz] to cap code and fine freq code.
200 '
210 I=1
220 IF F>FL(I) THEN I=I+1:GOTO 230 I=I-1
240 DF=INT(.5+(F-FL(I))*SL(I)+FCL(I))
250 IF DF<0 THEN OUT 1921,0:OUT 1920,255:GOTO 120
260 '
270 ' Output the codes to the VCO.
280 '
290 OUT 1920,DF      :OUT 1921,CC(I):II=0
300 '
310 ' Average the data over eight iterations.
320 '
330 FOR J=1 TO 8
340 II=II+INP(1922)
350 NEXT
360 II=255-II/8
370 LOCATE 16,20 : PRINT "ADC VALUE =";INT(II)
380 A$=INKEY$:IF A$<>" " THEN GOTO 120
390 GOTO 290
400 DATA      8,31,9.1667 ,  0
410 DATA     21,30,6.7857 , 70
420 DATA     36,19,2.5294 , 31
430 DATA     71, 7,2.1111 , 90
440 DATA    126,22,0.6081 , 15
450 DATA    201,22,0.5960 , 61
460 DATA    301,16,0.4699 , 78
470 DATA    553, 6,0.1521 , 23
480 DATA   1005, 2,0.1184 , 58
490 DATA   2009, 4,0.04332, 26
500 DATA   4001, 4,0.04814,112
510 DATA   6670, 0,0.01490,  0
520 DATA   7785, 0,0.01001, 16
530 DATA  14280, 0,0.01004, 81
540 DATA  30000, 0 0.00000,  0
```

AUDIO ANALYZER

Listing 8: *The Sweep program.*

```
10 ' AUDIO FREQUENCY ANALYZER  [SWEEP]
20 ' -------------------------------------------------------
30 ' This system will sweep through a frequency range and
40 ' display the responce to each frequency.
50 '
60 CLS:OUT 1923,137:DIM FL(14),CC(14) ,SL(14) ,FCL(14)
70 PRINT: PRINT"            AUDIO FREQUENCY ANALYZER"
80 '
90 ' Output the pulse to start the ADC conversion.
100 ' Also, park the VCO at the lowest frequency.
110 '
120 OUT 1921,128:OUT 1921,31:OUT 1920,0
130 '
140 ' READ THE CALIBRATION DATA FROM THE DATA STATEMENTS.
150 '
160 FOR I= 0 TO 14
170 READ FL(I),CC(I),SL(I),FCL(I)
180 NEXT
190 KEY OFF:IX=5
200 '
210 ' Input the lower and upper bounds of the range to sweep.
220 '
230 LOCATE 10,15:INPUT "FREQ LOW =";FL
240 LOCATE 12,15:INPUT "FREQ HIGH=";FH
250 FD=(FH-FL)/72
260 CLS
270 IF (FD>0) AND (FH<30000) AND (FL>8) THEN GOTO 330
280 CLS: LOCATE 3,30:PRINT"BAD FREQUENCY LIMITS"
290 GOTO 230
300 '
310 ' Print the axis on the screen.
320 '
330 FOR I = 1 TO 22:PRINT "-":NEXT:PRINT " ";
340 FOR I = FL+FD*3 TO FH STEP FD*6:PRINT USING " #####";I;:NEXT
350 FOR F = FL TO FH STEP FD
360 '
370 ' CONVERT THE FREQUENCY [F] FROM HERTZ TO CAPACITOR CODE AND
380 '     FINE FREQUENCY CODE.
390 '
400 I=1
410 IF F>FL(I) THEN I=I+1:GOTO 410
420 I=I-1
430 DF=INT(.5+(F+FL(I) )*SL(I)+FCL(I) )
440 '
450 ' If an incorrect code appears, then abort the run and start over.
460 '
470 IF DF< 0 THEN OUT 1921,0:OUT 1920,255:GOTO 230
480 OUT 1920,DF      :out 1921,CC(I):II=0
490 '
500 '  Delay to let the stereo settle to its response.
510 '
520 FOR T = 1 TO 50:I=I+1:NEXT
530 IF F=FL THEN FOR I = - TO 300: T=T+3: NEXT
540 '
550 ' Take eight samples and average.
560 '
570 FOR I=1 TO 8
580 II=II+INP(1922)
590 NEXT
600 II=II/8
```

(continued)

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```
610 '
620 ' Convert the data to a range of 1 to 22 for the screen.
630 '
640 I=INT(22-(255-II)/4
650 X$="+"
660 '
670 ' Check for out-of-range conditions
680 '
690 IF I<1   THEN I=1  :X$="^"
700 IF I>22 THEN I=22 :X$="#"
710 '
720 ' Place the mark on the screen.
730 '
740 LOCATE I,IX:      PRINT X$;
750 IX=IX+1
760 NEXT
770 OUT 1921,31:OUT 1920,0
780 LOCATE 23,1'END
790 ' ------------------------------------
800 ' - CALIBRATION DATA -
810 ' ------------------------------------
820 '     FREQ LOW, CAP CODE, SLOPE, FINE FREQ LOW
830 '
840 DATA       8, 31, 9.1667 ,    0
850 DATA      21, 30, 6.7857 ,   70
860 DATA      36, 19, 2.5294 ,   31
870 DATA      71,  7, 2.1111 ,   90
880 DATA     126, 22, 0.6081 ,   15
890 DATA     201, 22, 0.5960 ,   61
900 DATA     301, 16, 0.4699 ,   78
910 DATA     553,  6, 0.1521 ,   23
920 DATA    1005,  2, 0.1184 ,   58
930 DATA    2009,  4, 0.04332,   26
940 DATA    4001,  4, 0.04814,  112
950 DATA    6670,  0, 0.01490,    0
960 DATA    7785,  0, 0.01001,   16
970 DATA   14280,  0, 0.01004,   81
980 DATA   30000,  0, 0.00000,    0
```

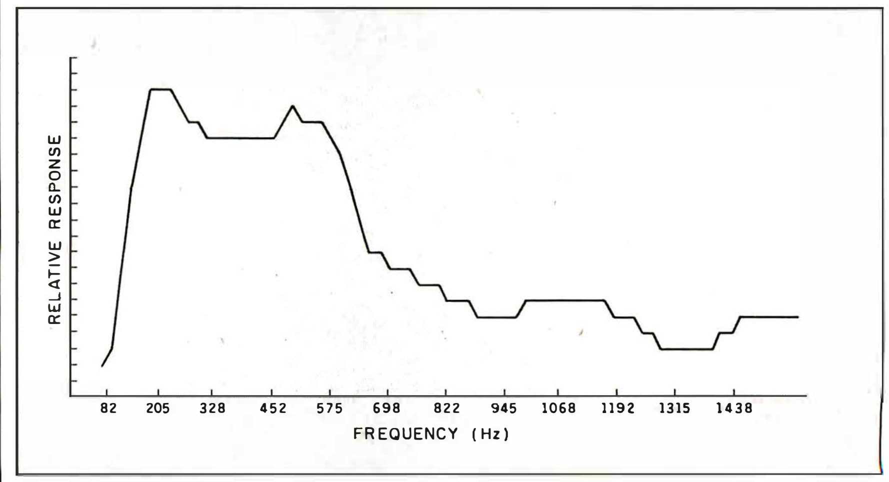


Figure 11: *Frequency response with all controls even.*



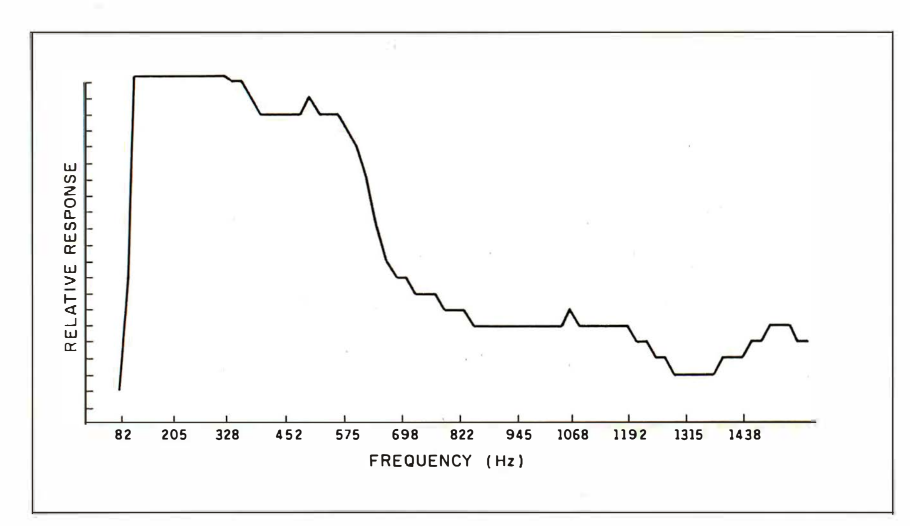


Figure 12: *Frequency response with full bass on.*

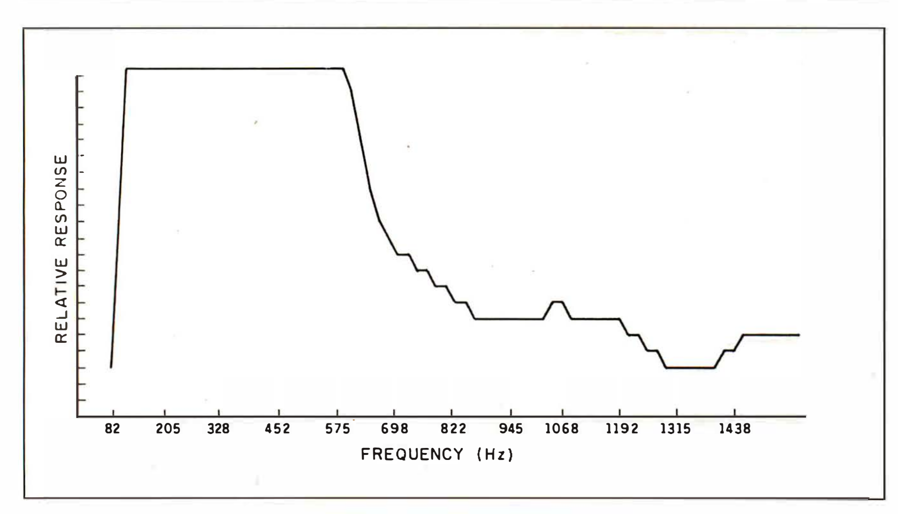


Figure 13: *Frequency response with loudness filter on.*

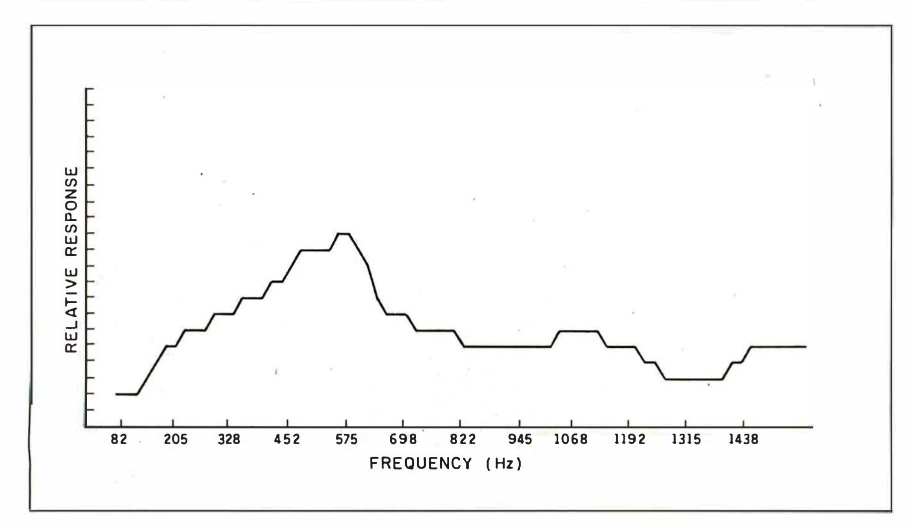


Figure 14: *Frequency response with full bass off.*

quency. The software then sweeps through this range and records the results. These results are shown on the screen as a graph with the frequency across the bottom and the computed value of the input up the side. There are no units for the vertical axis, it is just the relative power of the signal. The character "^" means that the signal went off the top of the chart. The character "#" means the signal went off the bottom of the chart.

SAMPLE RESULTS

I placed the microphone on a pillow to reduce noise. I connected the system to the right-channel Aux input of the stereo and set all the tone controls to the middle position; I set all the filter switches (loudness, high, and low) off. The most dramatic change happened in the lower frequencies, so I ran the Sweep program with limits of 20 to 1500 Hz. Figure 11 shows the results of this test. There was a peak at 200 Hz and at 500 Hz. Next, I turned the bass control full on, which gave the results shown in figure 12. Between 100 and 575 Hz the response went off the top of the scale. Above 800 Hz the two curves are similar. I then set the bass back to even and switched on the loudness filter. Figure 13 shows a boost in the frequencies below 500 Hz. The last test was to turn the loudness filter off and turn the bass control off. The results are shown in figure 14; they show that there was a small hump around 500 Hz. With some more fiddling with the controls, I reduced the hump and then adjusted the upper half of the spectrum.

CONCLUSIONS

You can use this system to test audio filters, graphics equalizers, or musical-instrument amplifiers. You can also use the output section alone as an audio-frequency generator or the input section with a microphone to monitor for a rapid change in sound or for an upper limit on the sound. Finally the I/O section can be adapted to many other projects besides the one I described. ■



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Each Kit comes complete with eight MM5290 (UPD416/4116) 16K Dynamic RAMs and documentation for conversion. Model 1: 16K equipped with Expansion Interface can be expanded to 48K with 2 Kits. Model III: Can be expanded from 16K to 48K using 2 Kits. Each Kit will expand computer by 16K increments.

TRS-16K3 200ns (Model III). $8.95
TRS-16K4 250ns (Model 1). $6.95

TRS-80 MODEL IV

Easy to install Kit comes complete with 8 ea. 4164N-20 (200ns) 64K Dynamic RAMs & conversion documentation.

TRS-64K-2 (Converts from 16K to 64K). $38.95
TRS-64K-2PAL (8 ea. 4164 w/Special PAL Chip to expand from 64K to 128K). . . $59.95

TRS-80 COLOR AND COLOR II

Easy to install Kit comes complete with 8 each 4164N-20 (200ns) 64K Dynamic RAMs and documentation for conversion. Converts TRS-80 Color Computers with D, E, ET, F and NC circuit boards to 32K. Also converts TRS-80 Color Computer II to 64K. Flex DOS or OS-9 required to utilize full 64K RAM on all computers.

TRS-64K-2. . . . . $38.95

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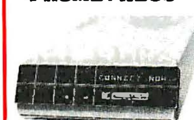
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XT300 (Output rating: 300 watts). $399.95

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The ProModem™ is a Bell 212A (300/1200 baud) intelligent stand-alone modem • Full featured expandable modem • Standard features include Auto Answer and Auto Dial, Help Commands, Programmable Intelligent Dialing, Touch Tone™ and Pulse Dialing & More • Hayes command set compatible plus an additional extended command set • Shown w/alphanumeric display option.

Part No.	Description	Price
PM1200	RS-232 Stand Alone Unit.	$349.95
PM1200A	Apple II, II+ and //e Internal Unit.	$369.95
PM1200B	IBM PC and Compatible Internal Unit.	$269.95
PM1200BS	IBM PC & Comp. Int. Unit w/ProCom Software.	$319.95
MAC PAC	Macintosh Package. (Includes PM1200, Cable, & ProCom Software)	$399.95

OPTIONS FOR ProModem 1200

PM-COM	(ProCom Communication Software). Please specify Operating System.	$79.95
PM-OP	(Options Processor).	$79.95
PMO-16K	(Options Processor Memory — 16K).	$10.95
PMO-32K	(Options Processor Memory — 32K).	$20.95
PMO-64K	(Options Processor Memory — 64K).	$39.95
PM-ALP	(Alphanumeric Display).	$79.95
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13⅛"L x 4¼"W x ¾"H

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KB-A68	68-Key Apple Keyboard only.	$ 79.95
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PCK-5	(5¼" Power Cable Kit).	$2.95
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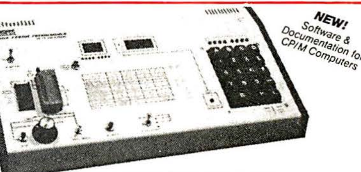
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JE664-A EPROM Programmer. $995.00

Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The RS232C Interface Option implements computer access to the JE664's RAM. This allows the computer to manipulate, store and transfer EPROM data to and from the JE664. A sample program listing is supplied in MBASIC for CP/M computers. Documentation is provided to adapt the software to other computers with an RS232 port. 9600 Baud, 8-bit word, odd Parity with 2 stop bits.

EPROM Programmer w/JE665 Option
JE664-ARS. $1195.00

Assembled & Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets the JE664 for the proper programming pulses to the EPROM and configures the EPROM socket connections for that particular EPROM.

JE664 EPROM Jumper Mod. No.	EPROM	Programming Voltage	EPROM MANUFACTURER	PRICE
JM08A	2708	25V	AMD, Motorola, Nat., Intel, TI	$14.95
JM16A	2716, TMS2516 (TI)	25V	Intel, Motorola, Nat., NEC, TI, AMD, Hitachi, Mostek	$14.95
JM16B	TMS2716 (3-V's)	-5V, +5V, +12V	Motorola, TI	$14.95
JM32A	TMS2532	25V	Motorola, TI, Hitachi, OKI	$14.95
JM32B	2732	25V	AMD, Fujitsu, NEC, Hitachi, Intel, Mitsubishi, National	$14.95
JM32C	2732A	21V	Fujitsu, Intel	$14.95
JM64A	MCM68764, MCM68L764	21V	Motorola	$14.95
JM64B	2764	21V	Intel, Fairchild, OKI	$14.95
JM64C	TMS2564	25V	TI	$14.95

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555-2	128K*	720K (2 drives)	1275.

*EXPANDABLE TO 256

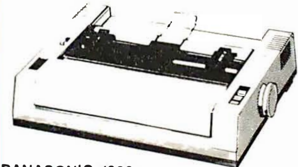
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ZW-151-52	320K	10.6 MB + 360	1PL/2 SER.	CALL
ZF-161-21*	128K	360	1PL/2 SER.	CALL
ZF-161-52*	320K	720 (2 drives)	1PL/2 SER.	CALL

*Portable

Panasonic.



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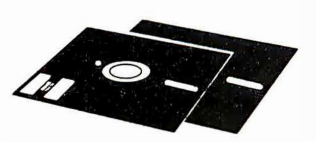
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100	1.59	2.19	3.22	3.56	CALL
10	1.62	2.23	3.29	3.63	CALL

VERBATIM Qty.	SS/DD	DD/DD	SS 96 TPI	DS 96 TPI	AT H DENS
200	$1.61	2.17	3.29	3.63	CALL
100	1.65	2.22	3.36	3.71	CALL
10	1.68	2.26	3.43	3.78	CALL

MAXELL Qty.	SS/DD	DD/DD	SS 96 TPI	DS 96 TPI	AT H DENS
200	$1.93	2.56	2.74	3.43	5.04
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10	2.01	2.66	2.86	3.57	5.25

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Brother HR-25 Daisywheel- 23 CPS Bi-Directional ....649.
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BY CHARLES BIGELOW

FONT DESIGN FOR PERSONAL WORKSTATIONS

Better fonts mean greater legibility and productivity

Business users are increasingly suspicious about the automated office. It has not provided the increase in productivity that system vendors promised. One reason for its failure is that the fonts on business systems have not been as legible as the traditional typefaces familiar to the office worker.

When a vendor claims that the fonts on a system are "pretty good" or "close enough" or "almost correspondence quality," this is the same as saying that the fonts are less than optimum and that the vendor has short-changed the reader on legibility. Considering the amount of time office workers spend reading digital fonts, anything less than the highest possible quality is counterproductive.

Until recently, few remedies were available for the problems caused by poor font designs for personal computers. The character-generator technology still used to produce letterforms on most computer terminals usually provides a single size of a single style of coarse-resolution dot-matrix letters. Character-generator technology usually does not let the user modify the fonts because the character images are contained in hardware or firmware.

Moreover, the designs of such fonts are often the work of people untrained in letterform design, while traditional lettering artists have rejected computers because the tools and output media of digital typography have been so clumsy and crude. The result is that most existing workstation fonts are not designed for optimum legibility even within the limitations of the technology.

Computer literacy has therefore been a good deal less pleasant and productive for the reader than traditional scribal and typographic literacy. The hackerish look of dot-matrix fonts on screens and printers has partially prevented full acceptance of computers as tools for a literate public.

Today, however, the look of computer fonts is undergoing a major change. The newer raster-based technologies of bit-mapped display and nonimpact printing offer potential solutions to many of the technical and aesthetic problems with digital fonts. These technologies can produce digital font images that more closely

(continued)



Charles Bigelow is Assistant Professor of Computer Science and Art at Stanford University. A MacArthur Foundation Prize Fellow, he organized the international seminar "The Computer and the Hand in Type Design" at Stanford in 1983. You can write to him at Stanford University, Department of Computer Science, Stanford, CA 94305.

resemble traditional analog typefaces.

The secret of designing digital fonts is to adhere to the principles of readability found in traditional letterform designs, while tuning the features and details of the design to the digital medium (for an example, see photo 1).

READABILITY

The resolutions of common bit-mapped screen displays range from 60 to 100 lines per inch, with an average of approximately 72 lines per inch. This is about one-tenth the resolution of average-quality digital typesetters used in the graphic arts and publishing industry.

It is a truism that communication of information is most effective and economical when the characteristics of the transmitter match those of the receiver. In literate communication, the transmitter is the system that produces the text image, and the receiver is the human visual system. The digital text image must contain as much resolution as the eye and brain can receive and interpret but need not contain more information than that.

There is a way to estimate the theoretical minimum resolution for good-quality digital text. Experiments by psychophysicists and perceptual psychologists suggest that the visual system cannot detect spatial frequencies greater than 60 cycles per degree of visual angle. That is, the visual system perceives a bar grating of regularly spaced black and white lines as solid gray if the spacing is so fine that more than 60 black and white line pairs are imaged in one degree of visual angle as measured at the retina. This provides a measure of the upper limits of the visual system's ability to resolve the kind of detail produced by a digital raster. At a reading distance of approximately 12 inches, 60 cycles per degree of visual angle is equal to a resolution of 300 cycles per inch at the screen.

We can now estimate the minimum resolution necessary for good-quality digital text by using a principle of digital signal-processing theory developed by Harry Nyquist at Bell Laboratories in the 1920s. It states that a signal can be digitally sampled and reconstructed without loss or distortion if the sampling rate is at least twice the rate of the highest frequency in the original signal. This minimum sampling rate is known as the Nyquist limit or Nyquist rate. Sampling below the Nyquist limit introduces aliasing, in which the high-frequency components of the original signal are erroneously reproduced as spurious lower-frequency components of the reconstructed signal. In digital typography, one form of these aliases is the jaggies—the jagged stair-step patterns that fringe the edges of digital type.

To faithfully sample and reconstruct a signal of 300 cycles per inch, you need a minimum sampling rate of 600 lines per inch. In fact, resolutions in the range of 600 to 720 lines per inch were used for many common digital typesetting devices developed during the late 1960s and the 1970s. A decade of experience with these machines showed that this resolution range was adequate for low- and medium-quality printing such as newspapers, telephone books, and magazines, but not for the highest-quality typesetting and printing, which required digital resolutions of 1200 or more lines per inch.

The Nyquist limit is only a theoretical minimum, and for high-quality letter images, real-world sampling rates often have to be higher. The practical evidence suggests that today's screen resolutions of 72 lines per inch are at least one or two decimal orders of magnitude too low to produce text of optimum visual quality.

The lesson here is that traditional analog typefaces cannot be imitated and jaggies cannot be eliminated on today's display screens. The only practical solution is to design screen fonts within the limitations of the available raster system, to optimize the font's features to the mechanisms of the human visual system, and to make sure these features conform to the

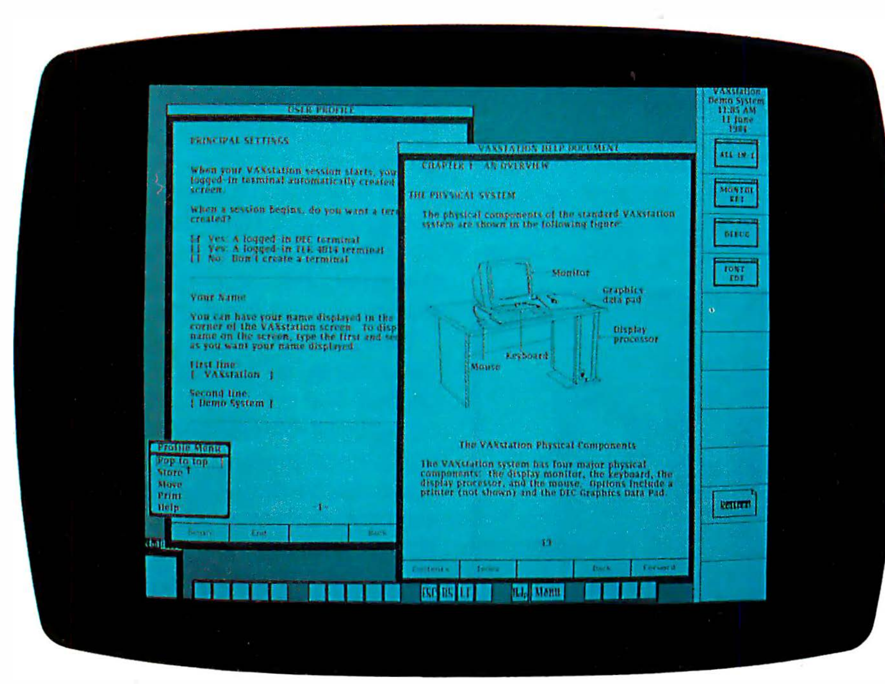
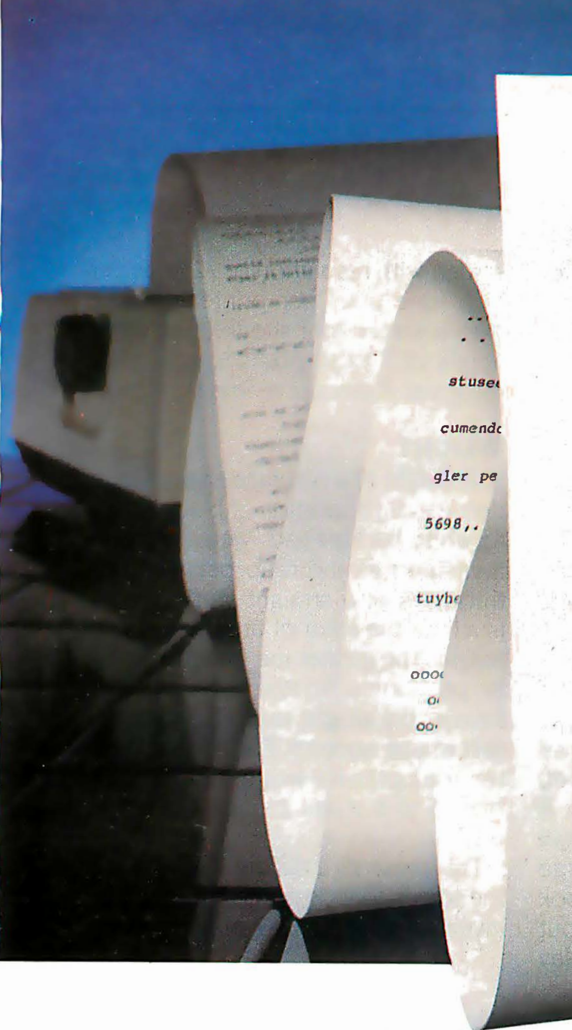


Photo 1: *Display screen of the* VAXstation 100, *a workstation made by* Digital Equipment Corporation. *The proportionally spaced screen fonts on the* VAXstation *are members of the* Pellucida *family, a set of original typeface designs optimized for legibility and clarity on bit-mapped computer displays. The characteristics of the* Pellucida *digital letterforms were developed by* Charles Bigelow *and* Kris Holmes.

(continued)



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KEYWORD

familiar historical principles of letter design.

Size

Type size is an important factor in legibility. Up to about 18 point (a printer's point is approximately 1/72 inch), the larger sizes are easier to read than the smaller. This article is set in 10-point type.

Most users view the screens of computer workstations at a somewhat greater distance than they do books and printed documents because paraphernalia such as a keyboard, mouse, or graphics tablet tend to intervene between reader and screen. Some ergonomic guidelines recommend a viewing-distance range of 16 to 28 inches; other guidelines recommend a range of 13 to 20 inches. At this distance, screen fonts should be about 1.2 to 2 times as large as printed text fonts.

This measure must be corrected for the fact that the apparent size of text in English (and other languages that use the Latin alphabet) is more dependent on the size of lowercase letters than on the body size of the whole font. Lowercase is measured by its "x-height," which is the vertical distance from the baseline (on which all the letters appear to sit or stand) to the top of the lowercase x. The body size of a font is the vertical distance from the bottom of a descender, such as the stem of a p, to the top of an ascender, such as the stem of a b.

The x-heights of common text types range from about 40 percent to 60 percent of the type's body size. A type with an x-height of 50 percent of the body is a face of medium-large appearance. A popular 10-point book face might have an x-height of about 5 points. If we assume a display screen with resolution of 72 lines per inch (one pixel per printer's point), then a screen font should have an x-height of 7 to 10 pixels to adjust for the greater average reading distance.

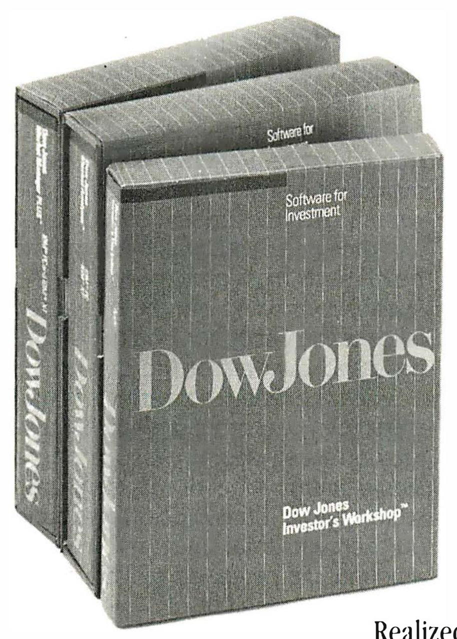
Weight

The weight of a typeface is its relative density, or proportion of black image to white background. Weight can be measured as the ratio between the thickness of a straight vertical stem (such as the stem of an l) and the x-height. The greater the stem thickness in proportion to the x-height, the heavier the weight, and the darker the text image appears. For printed matter, the optimum weight ratio ranges from 5 to 6 stems per x-height (5:1–6:1).

This presents a difficult problem for the screen font designer. For example, given an x-height of 7 pixels, a stem

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weight of one pixel is too light, but a stem weight of two pixels is too heavy. The digital raster cannot permit non-integer stem weights, and thus an optimum ratio seems impossible.

However, on a computer screen the perceived stem thickness is almost always different from the nominal thickness computed from the specified raster resolution. Physical factors that influence perceived stem weight include the size and intensity of the writing spot, the amount of spot overlap, the speed with which the writing beam turns from on to off versus the speed from off to on, the characteristics of the phosphor, and the brightness and contrast of the display.

When the letterforms are black and the screen background is white, these factors usually combine to erode a significant portion of the perceived stem weight. If this erosion is around 20 percent total (not an unusual amount), the perceived weight ratio of a font with x-height of 7 pixels and stems of 2 pixels would be approximately 4.4:1. While rather dark, this is preferable to a one-pixel stem, which would produce a weight ratio of 8.7:1—far too light and spindly. A larger x-height of 9 pixels with a stem of 2 pixels would, under the same conditions, yield a perceived weight ratio of 5.6:1, within the optimum range.

Thus, an interaction occurs between font size, as measured by x-height, and stem thickness that makes some size/stem combinations significantly more legible than others. A font designer has to filter the matrix of all possible low-resolution digital fonts to pass only those of acceptable weight ratios.

CONTRAST

In traditional text typefaces and lettering based on the Latin alphabet, vertical letter elements are thicker than horizontal elements. The stems of an n are thicker than the serifs or the connecting arch; the vertical bowls of an o are thicker than the horizontal hairlines. This difference between vertical and horizontal features is called contrast. Faces with high contrast have a brilliant, glittery look, and faces with low contrast have a stolid, monotonous look.

For screen fonts to have some of the legibility of traditional typefaces, the traditional contrast must be preserved. Fonts in which the vertical and horizontal elements are the same thickness have an unfamiliar texture; this unfamiliarity impairs legibility.

When both horizontals and verticals are only one pixel in thickness on a CRT display and the letters are black on an illuminated background, the legibility problem is exacerbated by the erosion of vertical stems, which become even thinner than horizontals, contrary to the reader's visual expectations. Such fonts not only appear weak and spindly, they seem unclear and ill-defined, as though the reader's vision is blurred or something is misadjusted on the display screen. What is actually blurred and misadjusted is the font's design. However, thicker stems require a larger x-height to maintain the proper font weight, so there is a lower limit to the size at which contrast can be implemented on a screen font.

SPATIAL FREQUENCY

I have discussed visual spatial frequency as a means of estimating the visual system's limits of sensitivity, but the lower spatial frequencies in text are even more important. Many psychophysical experiments suggest that the human visual system is most sensitive to spatial frequencies in the range from 2 to 6 cycles per degree of visual angle. A line of text contains multiple spatial frequencies; the fundamental one is the regular alternation of black vertical stems with intervening white counters (the space inside a letter like n or o) or inter-letter spaces.

Estimates of the fundamental spatial frequencies of printing types at text sizes show a range from 4 to 6 cycles per degree of visual angle, which is within the range of the visual system's peak sensitivity. When large text sizes (such as those used in luxury books where typographic econ-

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omy is not a factor) are included in the estimates, the range expands to include 2 and 3 cycles per degree, the remaining area of peak sensitivity. Type size and spacing are not arbitrary; they have been carefully tuned to the mechanisms of the visual system by centuries, even millennia, of careful experimentation. Screen fonts should also be tuned to this band of fundamental frequencies.

A failing common to many screen fonts is spacing between letters that is too tight in some combinations, too loose in others, and generally irregular. Irregular spacing between letters is faddish in advertising typography, where it serves to attract attention to sales pitches that the reader would otherwise ignore, but analysis of several centuries of typographic texts demonstrates that open, rhythmic spacing is the most readable.

PROPORTION

Because the alphabet is a system, the proportions of the letters must be tuned to each other and to the overall proportions of the alphabet design. The widths of the letters must conform to three main criteria: the x-height of the alphabet design, the optimum spatial frequency of the text, and the historically evolved letter shapes.

The average width of the letters in relation to the size of the font determines the fundamental spatial frequency of the font at a particular reading distance. This frequency should be within a certain range, as discussed earlier. Moreover, the different widths of the letters in relation to each other help the reader discriminate their forms and permit a rhythmic spacing pattern.

Proportionally spaced fonts are more legible than monospaced fonts because of the more finely tuned pattern of the text. When monospaced fonts are necessary, a font designer should compensate for the irregular rhythm and distorted proportions, but such compensation is possible only up to a point. The limitations of mechanical typewriter technology created a need for monospaced fonts, but these limitations are not necessary in digital typography. The less legible monospaced fonts can now be retired from most applications.

DIFFERENTIATION

Serifs act as flags on character shapes to aid in differentiation. Note that in a sans serif (i.e., without serifs) font, an r followed by n is easy to confuse with an m whereas the same combination in a serifed font is less easy to confuse with m. Similar demonstrations are possible for other letter combinations. Therefore, while sans serif fonts might seem more modern,

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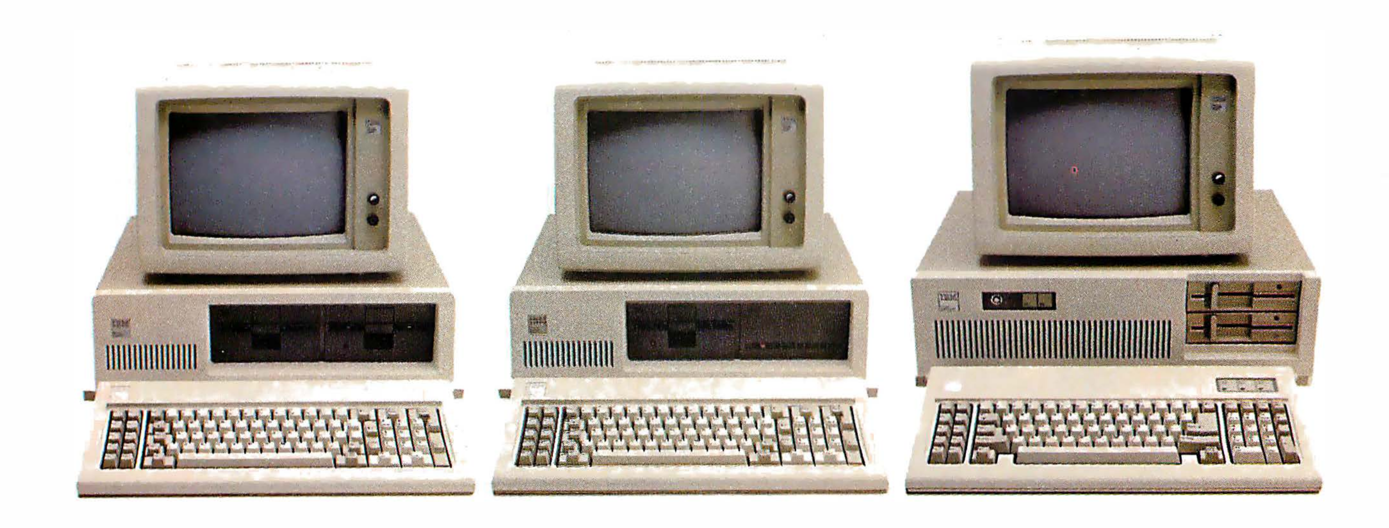
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they are less legible because they lack these significant distinguishing elements.

The construction of Latin-based alphabetic characters also aids in differentiation. These characters are like molecules constructed from simpler atoms. The primitive atomic elements are called strokes because they were originally a single motion of a pen or brush. The various kinds of strokes include verticals, horizontals, curves, and diagonals. The alphabet can be subdivided into groups of letters made up of particular primitive elements.

For example, in the lowercase, the letters n, m, h, r form one group based on the vertical straight stem and arch; o, c, e form a group based on the curved bowl; b, d, p, q form a related group based on the curve plus straight; and v, w, x, y form a group based on the diagonal. These groups help the reader to distinguish the letterforms.

Faced with the problem of screen jaggies, which are worst on curved and diagonal strokes, some font designers have reduced the letter shapes to straight vertical and horizontal elements. While this technique reduces the effect of the jaggies, it also destroys the legibility of the font by eliminating two of the four primitive elements and collapsing the form groups together.

When every letter in the alphabet resembles every other letter, the basic principle of discrimination is lost. While the jaggies are a problem, it is preferable to maintain the traditional shape primitives and keep the letterforms unambiguous, even if the diagonals and curves show jaggies.

GRAY SCALING

Low-resolution screen fonts are another problem for the designer. One technical response to this problem is to increase the display information from one bit per pixel (the black and white bit-mapped display of current workstations) to several bits per pixel (the gray-scaled display of some experimental and color workstations).

(continued)



Because they contain more information, gray-scaled fonts can better depict traditional letterforms, at least when viewed in isolated words and phrases. Also, the low-contrast edges of curves and diagonals reduce the visual effect of the jaggies. The letterforms appear smoother.

Some researchers have hypothesized that gray-scaled text would be more readable than bit-mapped text. Other evidence suggests that the eye relies upon high-contrast edges to focus the text image during reading. The soft, low-contrast edges of gray-scaled fonts might actually reduce legibility by preventing the focusing mechanism from finding a sharp edge. It is not yet certain whether the conservative eyes of readers will accept gray-scaled text, nor whether it is physiologically more difficult to read despite its less jagged appearance.

Gray-scaled fonts are also more expensive to display and more difficult to design. They require more bits of memory to store the gray value at each pixel, and more elaborate and stable display electronics. The shapes of gray-scaled letters are more dependent on precise control of brightness and contrast on the display.

SCREEN AND PRINTER

The foregoing principles have concentrated on designing screen fonts for optimum readability (for more information, see "Digital Typography" by Charles Bigelow and Donald Bay, *Scientific American*, August 1983). However, text is also read as printer output on paper. The relation between screen text and printer text is the subject of intensive research, with many recent efforts attempting to integrate screen and printer in what are called "what you see is what you get" (WYSIWYG) editing and layout systems.

The WYSIWYG principle is that the screen should show exactly how the printed document will look. WYSIWYG text editors and document formatters usually attempt to show different typeface styles in different sizes, spacings, and page organizations.

The usual model for WYSIWYG systems is traditional typography, which offers so vast and complex a range of possibilities that present WYSIWYG systems can offer only a reduced subset. This is true because 72-line-per-inch screens have only one-fourth the resolution of 300-line-per-inch printers, and one-tenth the resolution of 720-line-per-inch typesetters.

Usual WYSIWYG implementations fall into one of two categories: bottom-up or top-down. Bottom-up

(continued)

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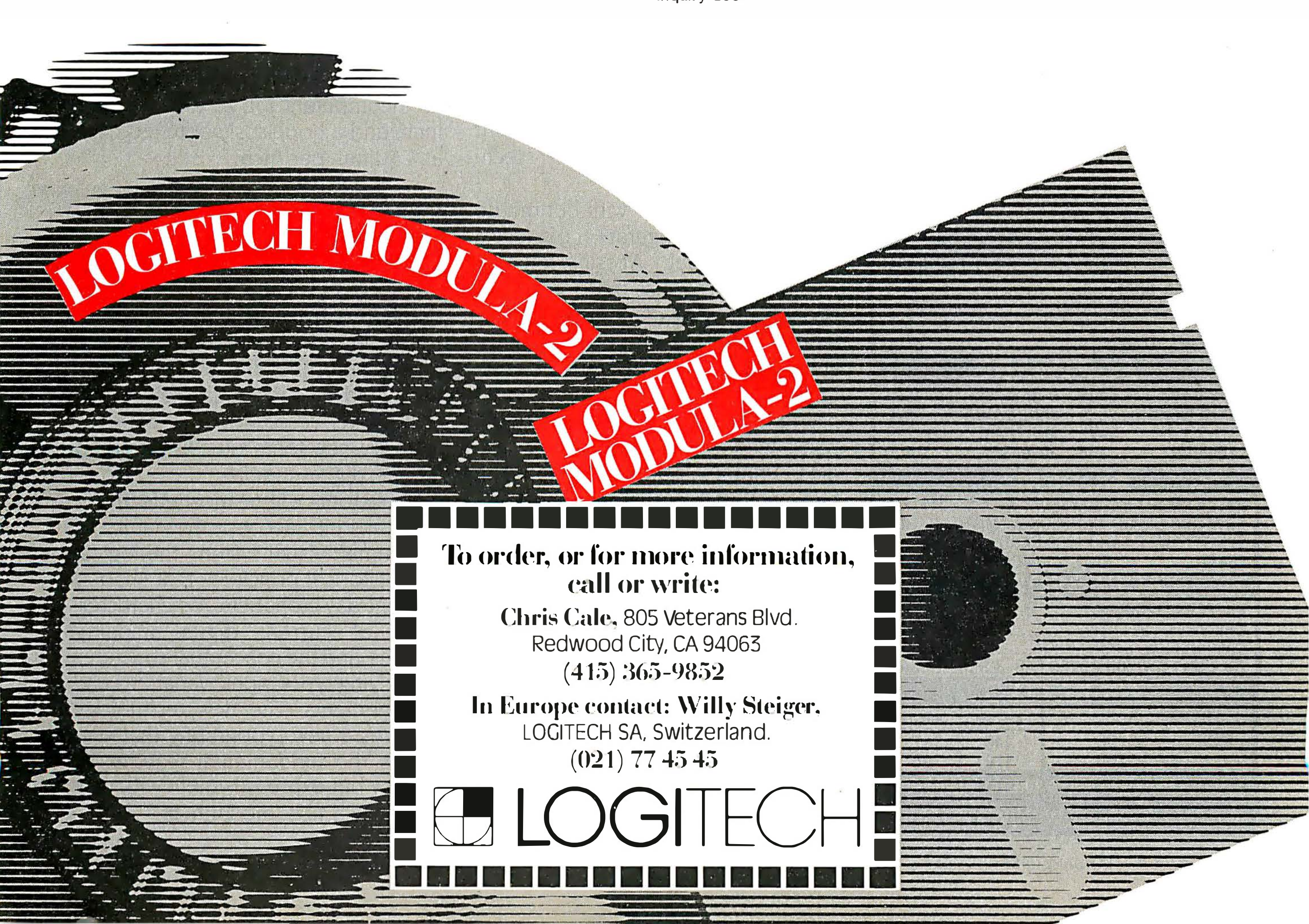
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WYSIWYG systems start with screen resolution and force the printer to conform to the limitations of the screen. In the simplest case, each screen pixel is mapped one-to-one onto the paper output by the printer.

While this provides a certain Cartesian satisfaction, since it can be logically demonstrated that the printer page is exactly like the screen display, the two images will actually appear very different. As I discussed earlier, the screen characters are eroded by the characteristics of the display technology. However, the printed characters are either emboldened, as by ribbon-spread on a dot-matrix printer or by toner effects on a black-writing laser printer, or not eroded to the same degree as the screen fonts, as by a white-writing laser printer.

Thus, if a font is tuned to the optimum weight and contrast on the screen, it will appear too dark and too low in contrast on the printout. Conversely, if the fonts are tuned to the printer, they will appear too light and too high in contrast on the screen. This is unavoidable. What you see is not what you will get at the present level of display and printer technology.

A second problem with bottom-up WYSIWYG is exaggeration of jaggies on the printout. Aliasing on the screen is somewhat ameliorated by the soft intensity contour of the CRT writing spot. The spot does not have sharp edges, nor is it square or rectangular; instead it is blurry and round. The low-contrast edges of the pixels tend to soften the apparent jaggies. Printers, however, produce a high-contrast spot that clearly renders the edges of the jaggies. The jaggies become even more apparent to the reader, since the human visual system tends to enhance edges.

On a laser printer that has several times the screen's resolution, several printer pixels render a single screen pixel. This emphasizes the rectangularity of the raster and further enhances the jagginess of the digital artifacts. Printer fonts that simulate screen resolutions look noticeably inferior to printer fonts that are optimized to the full resolution and imaging characteristics of the printer.

Top-down WYSIWYG systems store fonts as high-resolution master images. These are usually outlines that can be scan-converted to raster images to represent arbitrary sizes at arbitrary resolutions on screens, printers, or typesetters. This device-independent method is intellectually appealing, since the same design produces all characters at the writing resolution of each target device.

However, low-resolution and high-resolution fonts will not be truly the same. In top-down systems, the fonts on low-resolution devices become the inferior ones, both in comparison to high-resolution versions and to optimized low-resolution designs. The current generation of master-image data structures and associated scan-conversion algorithms can do good automatic rasterization at bit-mapped resolutions of around 1200 lines per inch, and an acceptable job at 600 lines per inch, but only a mediocre to inadequate job at 300 lines per inch, an incompetent job at 150 lines per inch, and a hopelessly botched hash at 75 lines per inch.

CONCLUSION

The personal workstation offers powerful tools to the worker, but these tools are dependent upon typography: legible fonts in effective arrangements. Unfortunately, traditional typefaces cannot be successfully reproduced at current display screen and printer resolutions. To optimize legibility, new fonts must be designed for the digital media.

These fonts will be most effective if they take into account the nature of the human visual system, the logical and historical principles that shaped present-day alphabets, the characteristics of current digital imaging devices, and the conceptual structures underlying typographic variations and arrangements. The new technology requires a new typography that preserves the fundamental features of literacy but expresses them with new clarity in a new medium. ■

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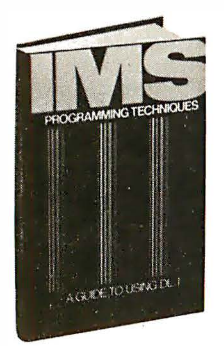


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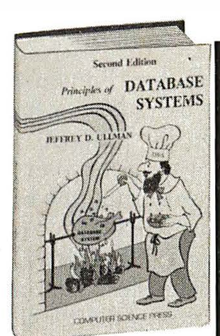
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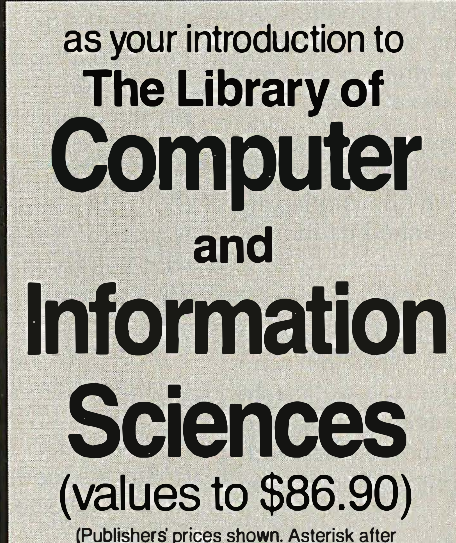
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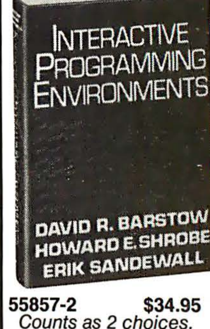


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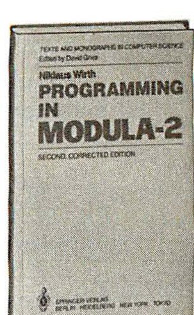


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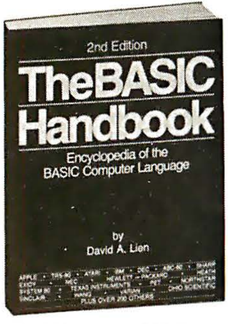




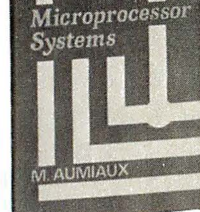
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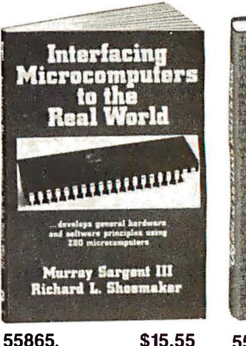
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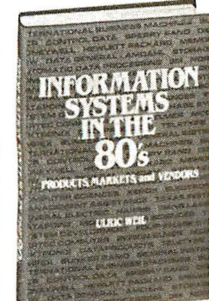
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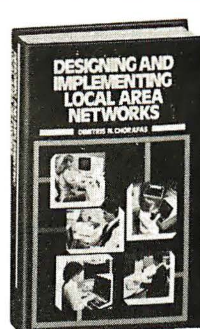
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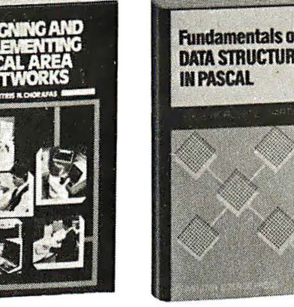
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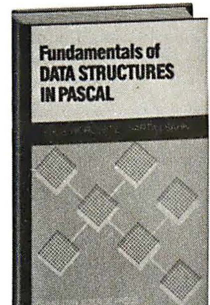


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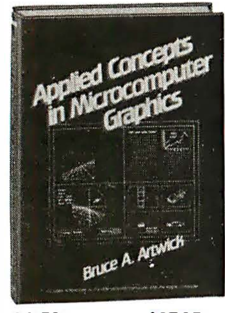


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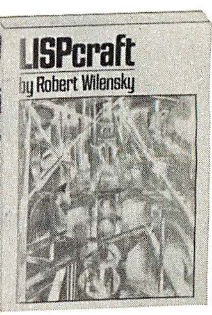


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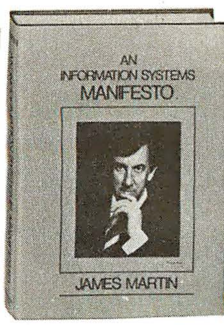
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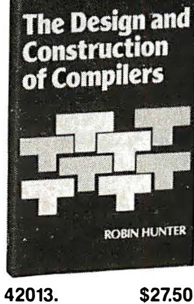
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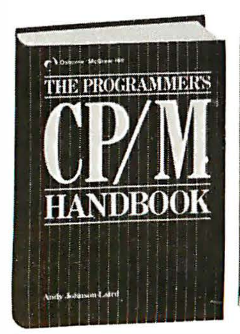
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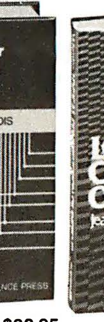
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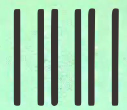
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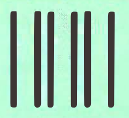
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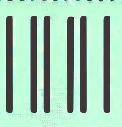
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BY BRUCE D'AMBROSIO

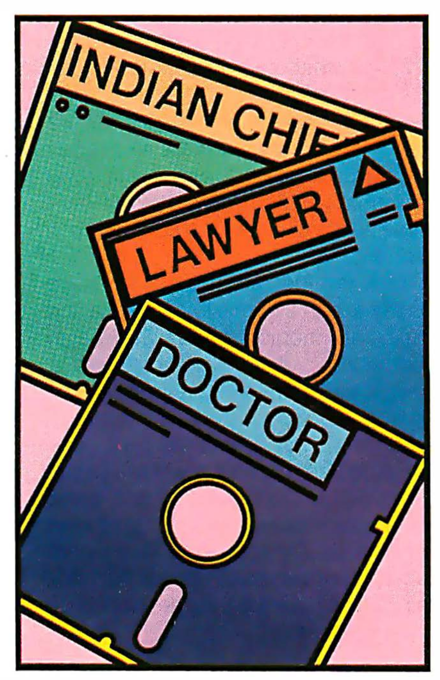
EXPERT SYSTEMS—MYTH OR REALITY?

The Department of Defense has identified artificial intelligence (AI) as one of the 10 most critical technologies to pursue in the remainder of this century. The Japanese have launched an ambitious fifth-generation computer project with AI's application, "expert systems," as one of its cornerstone technologies. The British and the French have responded with major national projects of their own. And the United States, currently the leader in this area, recently increased funding for basic research in AI. But what are expert systems, what is all the hoopla about, and is it justified?

A SHORT HISTORY OF AI

In the beginning there was the computer—and it was very difficult to program. Then John Backus et al. invented FORTRAN and the world of numeric programming was born. Shortly afterward, John McCarthy invented LISP and, with it, symbolic programming came into existence. In the same way that FORTRAN was an outgrowth of numerical analysis, LISP was basically an outgrowth of abstract mathematics, in particular Alonzo Church's lambda calculus. The result of this was that early users of LISP spent most of their time in search of those things that abstract mathematicians seem to love best—elegant and terse solutions to broad classes of problems. During the 1960s computer scientists developed a number of general problem-solving mechanisms, and in the late 1960s and early 1970s they tried to apply these mechanisms to "real" problems. For the most part, these attempts resulted in dismal failure. In fact, the results were so disappointing that one country, Great Britain, completely abandoned its AI research and development effort.

Artificial intelligence is being applied



What was the problem? Consider one particular case—that of determining the molecular structure of a compound when given its chemical formula and other information. This can be formulated as a "generate and test" problem. The system consecutively generates each of the possible structures the compound can have, based on its formula. It then tests the candidate structures against the other evidence to determine which one is correct. This algorithm works fine for a compound with few possible structures. However, the number of possible structures for any compound of interest to a chemist runs into the millions, and all hope of ever finding a solution vanishes, even on the fastest computers. The solution to this problem is not faster computers. Adding a single atom to a compound can increase the number of possible structures by a factor of hundreds, and computers are only getting faster by a factor of 10 or so each decade.

Researchers realized that what was needed was knowledge—enough information to understand the subject at hand. If, instead of generating all possible structures, the program only generated those that were physically realizable, the number of candidate structures would drop from millions to thousands. It would then become

(continued)

Bruce D'Ambrosio (2156 Word St., #4, Berkeley, CA 94705) has a B.S.E.E. and M.S. from the University of California at Berkeley and is still there working toward his Ph.D. He lists motorcycles as his hobby.

ILLUSTRATED BY CHRIS SPOLLEN

possible to test all candidates against the evidence to determine which would be the correct one. This is the approach that was taken in Dendral, a landmark AI system for elucidating chemical structure when chemical formula and mass spectrograph evidence are known.

PERSONAL COMPUTERS AND EXPERT SYSTEMS

Many people assume that AI and large computers are synonymous. This is less true today than it was in the past. For expert systems in particular, one of the promises is *inexpensive* distribution of expertise.

Much of the expert-systems development now taking place follows a fairly standard model. First, a production-rule interpreter is written in LISP, then the actual rules for an expert system are written. This has two impacts on the development environment. First, LISP itself is usually interpreted. That means that the final production rules are interpreted by a program that is also executed interpretively, and things run slowly. For this reason AI researchers like fast central processing units. Also, even if the production-rule interpreter is fairly small, the LISP interpreter must be in memory simultaneously (as well as all of the production rules themselves), and most serious LISP systems require at least 1 megabyte of main memory to run well. To my knowledge the only LISP systems available for computers with 64K bytes (or smaller) of address space are toys. Recently, however, Gold Hill Computer announced a LISP implementation for IBM PCs with memories of at least 256K bytes. While details about this system are still sketchy, this seems like it might be a product for building real systems. Still, interpreted LISP on a 5-MHz 8088 processor is almost useless because of its slowness. However, Gold Hill also says it will release a LISP compiler in the near future, and the system would then become a viable development tool.

More useful, but also more expensive, are the major research LISP systems that have been ported to several of the 68000-based UNIX systems currently available. However, with adequate memory (2 megabytes) and a hard disk, these cost $15,000 and up.

Another alternative is to abandon LISP. A major reason for building expert systems in LISP is that writing interpreters in it is easy. However, if you're more concerned with building rule-based systems than with experimenting with rule interpreters, you should be able to implement a rule interpreter in a language that makes more modest demands on computer resources. Several research projects have been conducted in which the system was designed in a LISP-based environment and then ported to either BASIC (Puff—a pulmonary diagnostic program developed by Stanford and UCSF) or FORTH (Delta/Cats—a locomotive diagnostic program developed at General Electric research). Both systems now run on a small PDP-11 and I have heard that Delta/Cats is being ported to an IBM PC. Also, rumor has it that IBM is developing an expert-system shell (rule interpreter and associated utilities) in Pascal for operation on a variety of their computers. Taking this approach, you should be able to develop a consultation-style expert system on a computer with from 128K bytes to 256K bytes of memory. Backward-chaining interpreters of the Mycin sort can be written so that their computation demands are also rather modest. In fact, consultation-style systems usually spend most of their time waiting for user input, rather than computing.

Disk facilities are not crucial, since many expert systems load all data and rules into memory before they begin operation. Again, 512K bytes to 1 megabyte of on-line storage should be adequate for both the rule interpreter and the text of several hundred rules. Most expert systems seem to require from 500 to 2000 rules. In fact, some of the new expert-systems producers have taken this approach. These start-up companies usually target IBM PCs as the hardware for their developed expert systems.

A second dominant theme in AI, "pattern-directed inference," was developed in the early 1970s. During this period, AI returned to its roots, so to speak, to pick up a technique for higher-level symbolic-program organization. This technique is alternately called pattern-directed inference or "production rules." Once the need for extensive domain-specific knowledge was recognized, pattern-directed inference seemed to provide an answer to the dual questions of how to represent this knowledge inside the computer and how to use it.

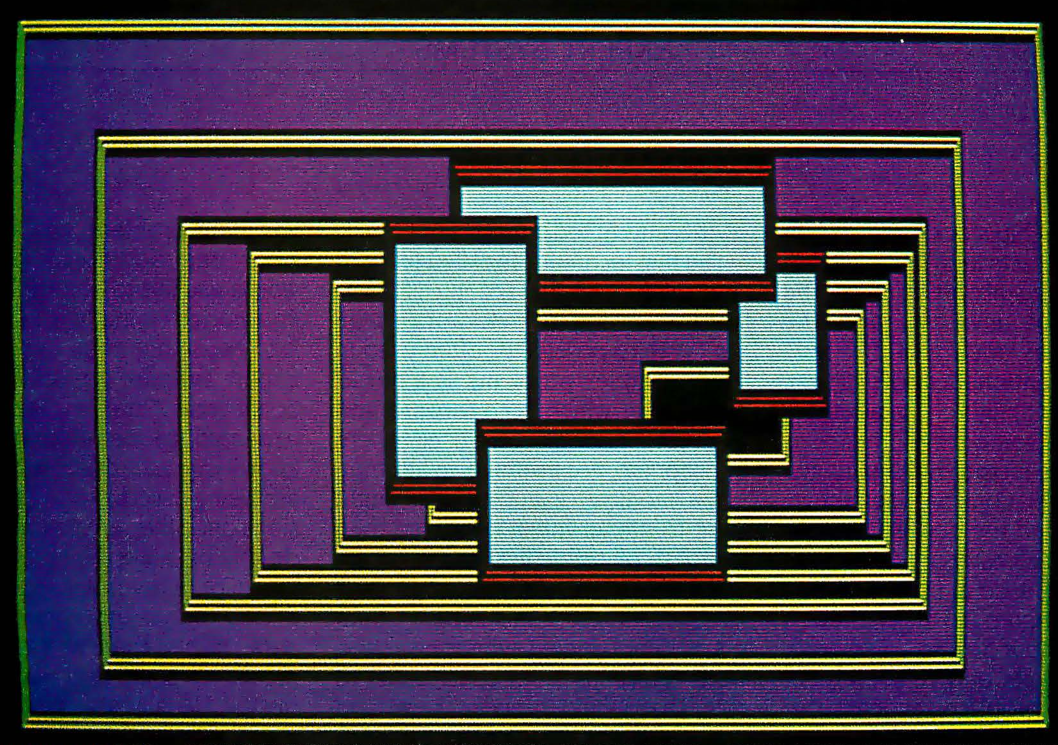
The twin themes, then, of extensive domain-specific knowledge and pattern-directed inference dominate expert systems work today.

KNOWLEDGE

It is all very well to say that a system needs knowledge, but, by itself, this statement is of little use in system design. Specifically, it raises two questions. First, what kinds of knowledge are needed? Second, how will this knowledge be used? In some sense, a house's furnace thermostat can be said to contain knowledge about heating houses, but no one would call it an expert system. At least three kinds of knowledge have been identified as useful for symbolic problem solving. These are simple domain *facts*, *relations* between these facts, and *methods* for using these relations in problem solving. (Other systems-development-related questions are addressed in the text box "Personal Computers and Expert Systems" at left.)

To make this taxonomy concrete, let's look at an example problem of determining where to invest some money. (A system that seriously addresses this question is far beyond the scope of this article. The following only suggests how you might use expert-systems technology to address this problem. Do not judge it for its financial acumen.) To simplify the problem, consider only three alternatives: a "safe" investment (e.g., Treasury bills or certificates of

(continued)



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deposit), blue-chip stocks, and growth stocks. Simple facts in this domain will include the age of the investor, the amount to be invested, and the amount already in each of the three categories mentioned above. These are formalized in figure 1. In addition, you will meet some simple relations between these facts to build your system, such as relations between the investor's age and the desired amount of money in each category. Some relations that might be in such a system are shown in figure 2. Finally, there is knowledge about how to solve problems, given facts and relations. For your sample problem, at least two strategies are possible. You could ask the user for all applicable information and use the known relations to deduce which investments are appropriate. Or you could try to prove that *each* possible form of investment is the proper one and ask the user questions as they come up in the course of the attempted proofs.

The first technique is called forward reasoning, and the second is backward reasoning or "backward chaining." A third possibility, often used in more complex problems, is a mixed strategy, in which both forward and backward reasoning are used where appropriate. For example, in attempting a medical diagnosis, you might want to gather initial data first, then establish plausible hypotheses to explain this data (forward reasoning from facts to conclusions), then predict unobserved symptoms (backward reasoning from conclusions to facts that would support them) and order tests to check for the presence of these unobserved symptoms (backward reasoning again), and finally use the test results to confirm or rule out the hypothesized diagnosis (forward reasoning again).

Now that you know what kinds of knowledge you need to solve the investment problem, you have to consider one additional factor. What would you like to accomplish with this knowledge? Initially, you want to use it to recommend an investment, but expert systems typically have additional goals. Often, expert systems are expected to be able to use their knowledge to explain why questions are being asked and to justify conclusions once they are reached. They can do this because the relationships between data items are represented explicitly within the system as further data, rather than as procedures or pieces of code (e.g., Pascal if statements). Usually, you should represent these relationships as *rules*, using a technique called pattern-directed inference.

age	The client's age in years
amount-to-invest	Amount the client wishes to add to his investment portfolio
safe-cash-amount	Amount the client has already placed in "safe" investments (e.g., T-bills or CDs)
blue-chip-amount	Amount the client has already tied up in "blue-chip" investments
growth-amount	Amount the client has already invested in "growth stocks"
safe-cash-target	Target amount the client should have in "safe" investments
blue-chip-target	Target amount the client should have in "blue-chip" investments
growth-target	Target amount the client should have in "growth stocks"
enough-safe	The truth of the statement "the client has enough cash in safe investments"
enough-blue-chip	The truth of the statement "the client has enough cash in blue-chip investments"

Figure 1: *Simple facts for the toy investment advisory.*

1 The client should have a reasonable amount of money in "safe" investments before entering the stock market.

2 The client should have a reasonable amount of money in blue-chip stocks before venturing into high-risk "growth" stocks.

Age	Amount in "safe"	Amount in "blue-chip"
< 30	$1000	$1000
30 — 40	$3000	$3000
40 — 50	$6000	$4000
50 — 60	$9000	$8000
> 60	$9000	$20000

Figure 2: *The informal statement of rules for the toy investment advisory.*

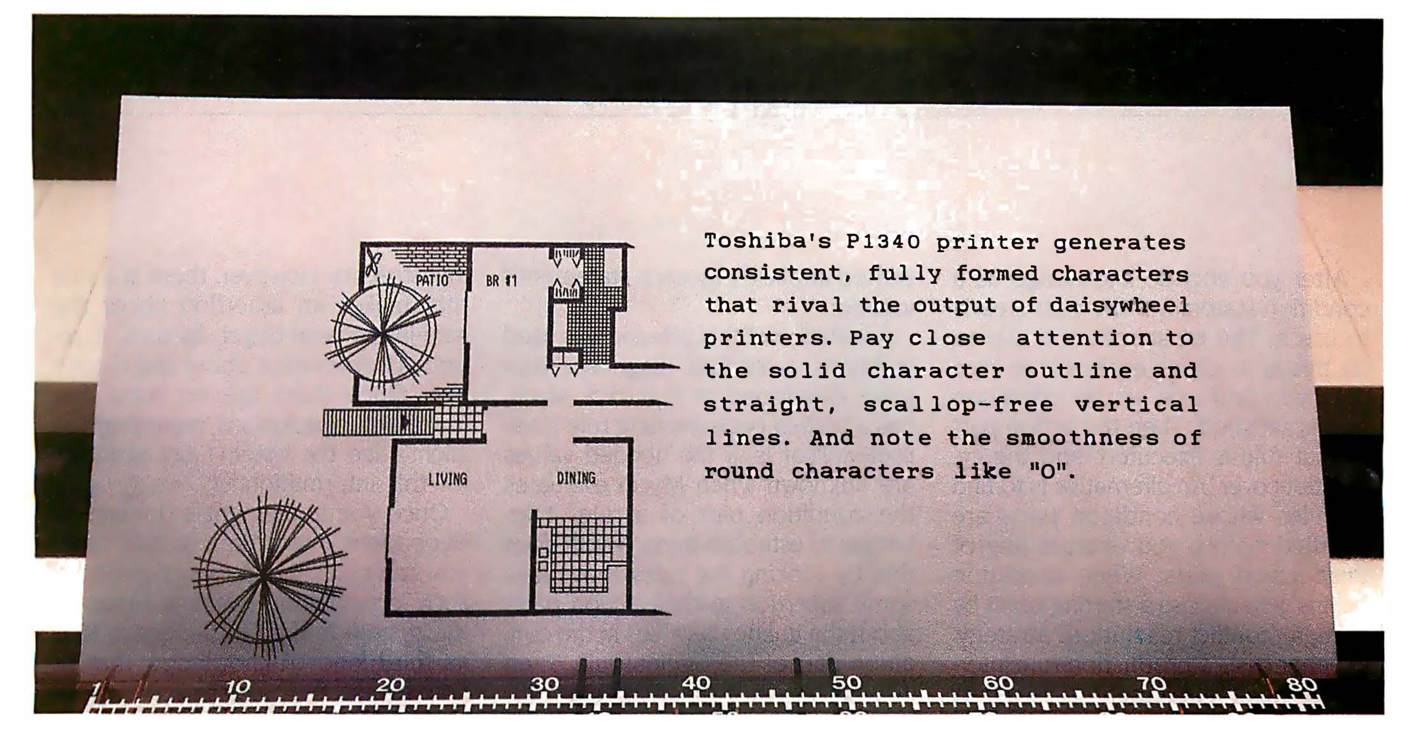
Pattern-Directed Inference

Pattern-directed inference is actually a rather simple technique. The basic idea is that you can express knowledge, especially relational and methodological knowledge, as a set of "condition/action" pairs. That is, if you can prove the condition part of a pair, then you get to perform the action part. The condition is a simple conjunction of elementary queries; it can be thought of as the if part of an if...then statement. I hope that the word "query" will make you think of database queries, which are similar. That is, the condition need not be a simple test as in the usual programming-language if statement. Rather, the condition can be more general, as in database-query language. For example:

```
IF (safe-cash-amount > safe-
    cash-target) and (blue-chip-
    amount > blue-chip-target)
THEN (invest growth-stocks
    amount-to-invest)
```

One difference between this example and a standard programming-language if statement is that both the "safe-cash-amount" and "safe-cash-target" may be unknown when the rule is first tested. Additionally, there may be several rules that can make conclusions about "safe-cash-target."

(continued)



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After you encode knowledge as a condition statement, the next step is to use it. The most common way to do this is to check each rule in turn until you find one whose condition part is satisfied. Then the action part of that rule is executed, and the cycle starts over. An alternative is to find all rules whose condition parts are satisfied before you execute any of their action parts. When execution begins, you choose a starting point by using a "conflict resolution" strategy. In either case, a production-rule interpreter must implement a two-part "recognize/act" cycle. The production-rule interpreter must first recognize which rules apply and then act (i.e., apply the relevant rule or rules). AI programmers have implemented many variations of this scheme, but you have to remember that this style of execution couples the rules loosely. In other words, it generally does not matter where you insert a rule in a production system. If you want to handle a new condition, you simply insert the appropriate rule, thus expanding system capability as in figure 3. This is in marked contrast to the usual "rat's nest" of if statements in a typical program. Normal if statements can be hard to update because their control information (that is, when they should be used) often is represented implicitly by each statement's location.

A variation of this scheme was used in Mycin, a medical diagnostic program developed at Stanford. Mycin has a built-in back-chaining rule interpreter. That is, if the needed values are unknown when Mycin evaluates the condition part of a rule, it attempts to establish them. Mycin does this by looking for rules that make some assertion in their action parts about the unknown values in the condition part of the original rule. Then it looks to see if these rules are executable. This might, of course, result in back-chaining to yet another level. Consider the following example. Suppose you want to show that blue-chip stocks are the appropriate investment for someone. You might have a rule that says: If the amount already invested in safe Treasury-note-type instruments is greater than the safe-investment-target amount, take some of that money out of those instruments and put it into blue-chip stocks. Through backward chaining, the system looks for rules that will first establish the safe-amount-invested, and then the safe-investment-target amount. There are no rules that draw any conclusions about the safe-amount-invested, so the system simply asks how much is tied up in "safe" investments. However, there is a rule that makes an assertion about the safe-investment-target. In turn, it requires information about the client's age. Since there are no rules that make any conclusions regarding the client's age, the system must again ask for this information.

Once you implement a domain-independent interpreter of this type, you can quickly build any number of such "consultation" systems. However, the system is rigid in the sense that its third kind of knowledge, that of how to use the rules to solve problems, is hard-wired. And because it's hard-wired, you can't build a more sophisticated forward- and backward-reasoning problem solver using a Mycin-style rule interpreter since there is no way to make it deviate from its built-in control strategy.

By examining its recursion stack, the rule interpreter can answer some questions the client might pose at this point. For example, if the client wants to know why the expert-system program is asking a particular question, the interpreter can answer by listing its "goals." The system asks the client's age to determine his "safe-investment-target" and attempts to determine his "safe-investment-target" to recommend an amount to invest in blue-chip stocks.

If the production-rule interpreter notes which rules were applied during the consultation, it can "justify" its recommendation by citing the rules it used to arrive at its conclusions. If the client asks why the system recommends he invest $5000 in blue-chip stocks, the system can respond: "Rule xx says that if your safe-investment-amount is greater than your safe-investment-target and your blue-chip-amount is less than your blue-chip-target, then you should invest X% of your net worth in stocks." This facility is especially important in systems designed to advise professional people, who don't often follow advice blindly. This brings up the final point: rule-based inference seems to be a natural way to express many kinds of knowledge, especially knowledge that

```
IF (enough-safe = TRUE) AND (enough-blue-chip = TRUE)
THEN (invest-growth (amount-to-invest))

IF (safe-cash-amount ≥ safe-cash-target
THEN (enough-safe TRUE)

IF (age < 30)
THEN (safe-cash-target $1000)

IF (age ≥ 30) AND (age <40)
THEN (safe-cash-target $3000)

IF (age ≥ 40) AND (age <50)
THEN (safe-cash-target $6000)

IF (age ≥ 50)
THEN (safe-cash-target $9000)

IF (client-in-rush = TRUE)
THEN (enough-safe TRUE)
```

Figure 3: *The formal statement of some of the rules for the toy investment advisory. Note the last rule. This is an example of how new rules can be easily added to modify the performance of a rule-based system after the system has been constructed.*

(continued)

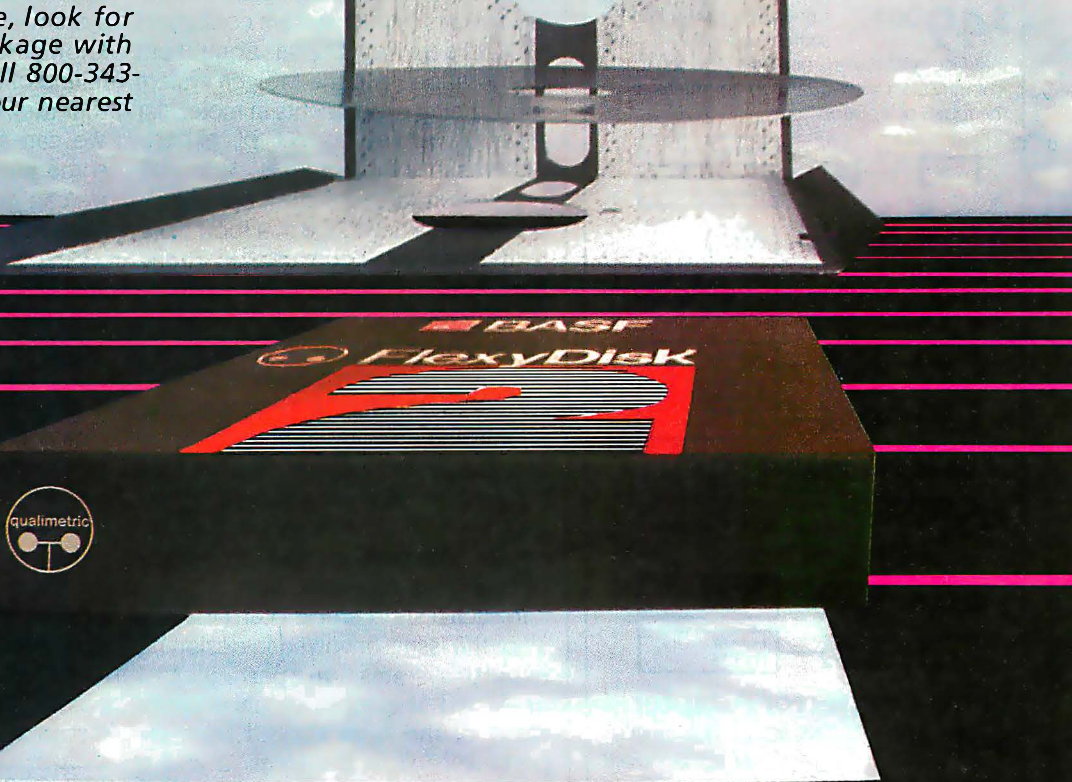
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Putting the Pieces Together

You now have three kinds of knowledge and a pattern-directed inference system for using this knowledge to solve problems. What can you expect from them?

Expert systems are best at solving data-interpretation problems, such as inferring situation descriptions from sensor data. HASP/SIAP, for example, is a system that can infer the locations and types of ships traveling in the Pacific Ocean from data transmitted by a network of submerged acoustic sensors. Other successful AI systems include the Mycin medical diagnostic system, the Delta/Cats mechanical diagnostic system, the R1 design system for configuring objects under constraints (the R1 system configures VAX orders for Digital Equipment Corporation), and the Molgen system for planning experiments in molecular genetics. A key aspect of expert-systems technology is that its production-rule formalism permits expression of knowledge in a form close to the way an expert uses it. Therefore, systems can be built by interviewing relevant experts and directly coding their problem-solving knowledge into rules. Such systems provide expert-level performance by giving us an automated copy of human expertise. This is the reason for much of the current excitement about expert systems. The technology promises to be an inexpensive way to widely distribute human expertise.

In such a short article I can't discuss all of the issues involved in designing expert systems. In particular, I neglected the topic of uncertainty. Many of the rules elicited from experts will follow the form "a and b together often imply c," and the data available for problem solving is often either unreliable or vague. Many expert systems have built-in facilities for dealing with uncertain information. These may include an ability for a "degree of belief" about various facts (e.g., medical diagnosis) or the ability to make an assumption and later retract it if it leads to undesirable results (as in a planning system).

Successful as expert systems have been, several major problems limit their applicability. First, the technology described here has no way of recognizing when a problem is outside its domain of expertise. If you present Mycin with a broken arm, it may not only fail to recommend a cast, but it might not even recognize that this patient's ailment is beyond its scope. Connected with this is the liability that Mycin has no independent way to check that its conclusions are reasonable. Also, the "explanations" that expert systems can give are shallow and do not really address fundamental issues. For example, in our toy investment advisory, you can't ask why a person under 30 should have $1000 in "safe" investments. The system does not know why, it only knows the fact. And perhaps a major failing of all current expert systems is that they can't learn from experience. We can accept that human experts sometimes make mistakes; however, we can generally expect a person to learn from that error and not repeat it.

Despite these failings, all of which are being researched, the current generation of expert systems offers a higher level of performance than more traditional programming techniques. You can expect to see their increasing use in more and more situations where expert advice is widely needed and in short supply. So far, this has already happened in the field of finance. Deregulation has expanded the number of financial services beyond the number of knowledgeable financial advisors. As a result, several companies are pursuing the possibility of using expert systems to distribute their financial advice. ■

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3. Winston, P. *Artificial Intelligence*. Reading, MA: Addison-Wesley, 1977.

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Reviews

THERE'S A CERTAIN understandable fascination with the idea of a computer small enough to go with you anywhere yet powerful enough to handle your work without forcing you to make excuses. We're not exactly up to our chins, or laps, in these briefcase-size machines, but enough are now coming out so that we can see they're being regarded as useful devices rather than curiosities. The HP 110, reviewed this month by Mark Haas, fills the description of briefcase-size (13 by 10 by 2⅞ inches, 9 pounds). As to whether it's a tool or just a conversation piece, Mark's review provides an answer.

Our second review details the other end of the fashion spectrum. S-100 systems are far from new but have shown a resiliency that belies the occasional news of their demise. As evidence, Charles Strom presents Gifford's MP/M 8-16, developed from CompuPro hardware and Gifford's operating system, with a variety of disk controllers and other options. The Gifford MP/M 8-16 won't be joining you in the coach section of the airplane, but there's an interesting story here, told by an informed user.

We previewed Lotus's Symphony back in July when those cryptic television commercials first appeared. At the time we promised we'd come back to it after giving it a more thorough going-over. Dick Pountain, BYTE's U.K. editor, fulfills our promise, pointing out some of the differences between its rumored attributes and reality. If you're at all interested in integrated software, this is an article you should read.

For readers looking for a way to create finished documents with a professional, typeset appearance, Alan Miller has reviewed MagicPrint from Computer EdiType Systems. A print processor rather than a word processor, MagicPrint has specific applications and specific limitations you should be aware of before you buy.

The subject of printing is taken up from another angle in Mark Haas's review of the HP ThinkJet printer. Mark reports on its pluses and minuses and gives close inspection to some of its more curious aspects.

Finally, we called on Mr. Haas again to give us a review of the TI Omni 800/Model 855 printer. This unit has plug-in ROM cartridges that carry the different fonts and can give you more variety in document preparation. A nice idea, but how well does it deliver? Mark gives you a pretty good idea.

—Glenn Hartwig, Technical Editor, Reviews

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Inquiry 22

The PFS Series of software from Software Publishing (1901 Landings Dr., Mountain View, CA 94043) has been popular for quite some time. All the entries in this series (pfs:File, pfs:Report, pfs:Graph, and pfs:Write) are relatively inexpensive and easy to use. Though they are not extremely powerful, they represent one of the best software values on the market. IBM used them as the basis for their Assistant series of software.

The only gap in this series was the absence of a spreadsheet program, and now that gap has been filled by pfs:Plan. This spreadsheet program was designed with some minor deviations from the Visi–Multi–1-2-3 school of thought. The titles for each column and row are always present on the screen no matter where you are in the sheet. Formulas appear in the margin of each row or column. This is helpful, but writing formulas for individual cells can get pretty complex. Also, pfs:Plan recalculates at about half the speed of Multiplan on the IBM Personal Computer (PC). This program seems well suited to shorter, simpler spreadsheet models and seems to integrate well with pfs:File databases. It will not replace Multiplan as the current spreadsheet of record, but at a list price of $140, it seems to be a fairly good bargain, especially if you already have one of the other PFS packages.

I was really looking forward to the new Commodore Plus 4 from Commodore International (1200 Wilson Dr., West Chester, PA 19380). Computers from Commodore have tended to be somewhat erratic, but the best-selling Commodore 64 is, despite its flaws, one of the best bargains in the industry. And now that it is so popular, it has become the beneficiary of some pretty good software. I was hoping the Commodore people would allow the new Plus 4 to take advantage of this huge software base and would add built-in software that would be comparable to the excellent third-party software that is available.

Unfortunately, this is not the case. The $300 Plus 4 is only slightly compatible with the 64, and the software that is included with the machine is just a tiny bit better than bad. For example, the maximum length of a document in the word processor is 99 lines of 77 characters each. (Just the right length for a complaint letter to a computer manufacturer.) Another thing, in order to insert a character, you first have to insert a space and then write over the space with the character. The spreadsheet and database programs are similarly underpowered and hard to use. This machine should have been called, not the Plus 4, but the Minus 60. A Commodore 64 with Multiplan from HesWare (150 North Hill Dr., Brisbane, CA 94005), a word processor such as WriteNow! from Cardco Inc. (313 Mathewson, Wichita, KS 67214) or SkiWriter II from Prentice-Hall Home Software (POB 819, Englewood Cliffs, NJ 07632), and some public-domain database programs (from CompuServe) would cost less and would vastly outperform this machine. We'll cover this in more detail later.

Telecommunications seems to have become one of the more popular reasons for buying a microcomputer. Indeed, modems are outselling most other computer peripherals. The problem is that most of the databases accessible to personal computers haven't changed since the days when mainframes ruled the computer world. The emphasis on user friendliness, a prime component of any personal computer product, seems to have completely bypassed these large and potentially intriguing databases.

To help us out, the Business Computer Network (BCN) (POB 37, Technical Research Park, Riverton, WY 82501) has given us SuperScout, a combination database gateway and communications software package. When you sign on to SuperScout, you are automatically signed on to about 10 databases at the same time. The most important of these is CompuServe, but Dialog and NewsNet are also there. BCN handles all the initiation costs for these services and even provides you with a free communications software package. This software package presents you with a menu of all of the databases available, calls the selected database, and takes you through the log-on procedures. This software will also automatically update itself as more databases are added. BCN charges you 25 cents over the cost of each database access, with a $5.00 minimum charge each month.

One problem with SuperScout is that it is so automatic, you are not sure what it is doing. It seems to take over your computer and to start making mysterious phone calls without asking permission. As you watch your modem lights go on and off, you wonder who SuperScout is calling and what devious schemes it is planning with other computer systems. Another problem is that you do not get the original manuals for each database. You get BCN's version, which is adequate but not comprehensive. However, you do get a nice glossy monthly update from BCN explaining the changes in each database.

A well-mannered program should never use your phone without asking. SuperScout is certainly user friendly, but I wish it were more "user courteous."

—*Rich Malloy, Product-Review Editor*



S·Y·S·T·E·M R·E·V·I·E·W

The HP 110 *Portable Computer*

A small package with powerful capabilities

BY MARK HAAS

In many ways more powerful than popular desktop computers, the HP 110 (see photo 1) combines an impressive array of hardware and software components in a compact, truly portable machine. Although its price might surprise you at first, a closer look reveals a computer with true desktop capability and performance well worth its cost for those who need the power.

The HP 110 measures 13 inches wide, 10 inches deep, and 2⅞ inches high when closed, and weighs in at nine pounds. It contains an 80C86 microprocessor, the CMOS (complementary metal-oxide semiconductor) version of the 8086, with a clock rate of 5.33 MHz—about 12 percent faster than that of an IBM or Compaq personal computer. Memory consists of 272K bytes of CMOS static RAM (random-access read/write memory) and 384K bytes of ROM (read-only memory). The ROM contains a full complement of software ranging from Lotus 1-2-3 to a set of preliminary diagnostic programs. A disk supplied with the HP 110 contains some MS-DOS utilities, the Lotus tutorial, and more extensive diagnostic programs. The HP 110 also contains a 300 bit-per-second (bps) modem, a clock/calendar, an RS-232C port, and a Hewlett-Packard Interface Loop (HPIL) port. The cover over the keyboard flips up to reveal an 80-column by 12- or 16-line liquid-crystal display (LCD).

The LCD tilts up and you can vary the display angle for optimum viewing. You can control the contrast from the keyboard. Comprising an array of 480 by 128 pixels, the LCD can display text as well as graphics. The LCD is actually a 16-line window into a larger display area. For example, when using the terminal-emulation software built into the HP 110, you can move the window through a 48-line display. You can move forward and backward a screen at a time by using the Prev and Next keys. Hewlett-Packard is about to release a version of Microsoft's GW-BASIC that will allow greater access to the display's graphics capabilities (it should be available as you read this review).

The keyboard (photo 2) has a nice feel to it, slightly stiffer than the Tandy Model 100's keyboard, but otherwise far superior. It has sculpted keytops and virtually no wobble in the keys. I think it will stand up to a lot of pounding. The 76 keys are arranged into six groups according to function: alphanumeric keys, display-control keys, edit keys, function keys, function-control keys, and terminal-control keys.

The computer is powered by a 6-volt, 2.5-ampere-hour sealed lead-acid battery good for up to 16 hours of operation on a single charge. The charge remaining in the battery is indicated in a window on the main PAM screen (described below). A recharger plugs into the back of the HP 110. It provides a 95 percent charge after being connected for 12 hours if the unit is off, or 20 hours if the unit is on. Should the battery charge fall below a predetermined level, a low-battery indicator will appear in the lower left corner of the screen and reappear every eight minutes as long as the battery is low. At this point you have enough juice for about one and a half to two hours. If you let the charge drop further, the HP 110 halts all normal operations. The clock and the memory are preserved, however, for one week to one month.

LIVING WITH PAM

Like the larger desktop HP 150, the HP 110 comes with an operating system named PAM (Personal Applications Manager). PAM is a software utility designed to insulate the user from the nasty operating system. When I reported my impressions of PAM as implemented on the HP 150 (November 1984 BYTE, page 262), I was less than enthusiastic about it. When I first turned the HP 110 on, there was the now-familiar PAM main screen (see photo 3) showing me what applications I could start and what functions I could perform, as well as providing me

Mark Haas (2600 Tenth St., Berkeley, CA 94710) is the technical director for Osborne/McGraw-Hill.

with some system statistics.

I grew to like PAM on the HP 110, though it took me some time to figure out why. I decided that PAM was successful on this machine because it was fast and less cumbersome to use than on the HP 150. Also, the system overhead for PAM is low. As it turns out, all these improvements can be explained by one factor: software in ROM.

Having software in ROM is like having a hard disk. Well, maybe a read-only hard disk. It is fast, nonvolatile (unerasable), and always there. You are not burdened with over 100K bytes of system files on every floppy disk. You don't have to search for the floppy that contains MS-DOS installed as an application if you want to venture into the operating system. You don't have to go through cumbersome installation procedures for every new application.

PAM on the HP 110 also has some nice new features. You can schedule alarms—either message alarms to remind you of meetings and birthdays or program alarms that tell the HP 110 to run a program or batch file. This is all controlled by a file you create called PAM.ALM. Each line of this file controls one alarm and contains the date and time for it. It also contains either a message to remind you of something or a command as you would enter it at the MS-DOS prompt.

PAM.ALM is easily updated using the built-in MemoMaker word processor. The only other requirement is that the alarm entries in the file be in chronological order. The file length is limited only by memory, and you can schedule alarms months (even years) in advance or as rapidly as one minute apart.

If you happen to be in another application when an alarm goes off, you will hear a warbling tone signaling you to retrieve your message. You must return to PAM to see the message or have another program execute. If the computer is off, the alarm will turn it on. Up to eight message alarms will be stored if you're not around to answer them or are too busy with another application, but only the first program alarm will be retained if it goes unanswered.

I used this feature quite a bit, mostly as a message alarm, and liked it very much. It reminded me of meetings and phone calls to make, and told me when to go home. It did seem to have one small bug, though. Sometimes after I returned to PAM from answering an alarm, the next application I tried to run would abort and I'd be returned to PAM. After that everything worked fine. It seemed to happen only when I stopped the alarm by pressing a key instead of letting the alarm run its course (about 10 to 15 seconds).

PAM has another special file it looks for called AUTOANSR.BAT. If the HP 110 is connected to the phone line and the phone rings, you will hear a low tone. If you are in PAM or the file manager and the AUTO-

(continued)



Photo 1: *The HP 110 Portable Computer.*

ANSR.BAT file exists, PAM will execute it. I did not test this feature.

Finally, installing new applications in PAM has been greatly simplified. It is necessary to add only two lines to a file you create called PAM.MNU. The first line is the label that will appear in the box in PAM's main screen. The second is the actual command line. You do not need to list every file involved or the total size of all the files as with PAM on the HP 150. If you are using external disk drives, you simply create a PAM.MNU file on each disk. It's a very small file, typically occupying less than 512 bytes.

One thing missing from this version of PAM is the Browse function of the file manager that lets you look at the contents of a file. I do miss that, but ROM space was at a premium according to Hewlett-Packard.

OTHER ROM SOFTWARE

Besides PAM and MS-DOS, HP has included a complete set of what have become known as productivity tools: a spreadsheet, database, graphics program, word processor, and communications package.

Probably the single most unique feature of the HP 110 is Lotus 1-2-3 in ROM. This program alone will likely account for more HP 110 sales than any other single feature. This is a full version 1A of Lotus 1-2-3; nothing has been left out. Two utilities, Printgraph and Translate, and the tutorial are contained on an external floppy disk.

Lotus 1-2-3 loads with blinding speed. Less than three seconds after selecting this application from the PAM screen, you are ready to start. Worksheets load equally quickly, as the benchmark results indicate.

Recalculation is almost instantaneous, due in part to the efficiency of the 80C86 processor, which scores extremely well in the BASIC single-precision and Sieve benchmarks. Graphics on the LCD are perfectly presentable, although the pie charts would more aptly be called egg charts. It appears that the graphics routines for drawing circles still expect the normal CRT (cathode-ray tube) aspect ratio where it takes fewer dots to draw a line of any given length vertically than horizontally. On the HP 110's display, the aspect ratio is 1 to 1, and no compensation is necessary.



Photo 2: *The keyboard of the* HP 110.

MemoMaker is HP's word processor. It is easy to use and works well, but it is somewhat limited in function. For instance, it does not have a Search and Replace function. It is a "what you see is what you get" word processor that HP describes in its manual as "for people who need to write although their primary occupation is not writing." I don't think that's entirely true; HP might be shortchanging itself.

MemoMaker is perfectly adequate for preparing first drafts of manuscripts and performing light editing on them. For more extensive editing after the first draft is down, you would need a more powerful word processor. This could always be done on a desktop with a larger display or with the version of WordStar for the HP 110. I didn't spend too much time with MemoMaker, preferring to try out a prerelease version of WordStar instead. But I did find MemoMaker useful for creating system files such as PAM.ALM and installing new applications into PAM.

MemoMaker is described by HP as having WordStar-compatible files. However, later in the documentation HP admits to compatibility with WordStar document files "to a limited degree." In my opinion, the degree is very limited. The only features MemoMaker preserves are Control-B and Control-S used for boldface and underline, respectively. Soft carriage returns and hyphens are not preserved, and all other control codes are stripped. This won't pose much of a problem for someone preparing a manuscript but would be an obstacle to anyone preparing a finished-looking document.

THE PORTABLE AS TERMINAL

Because of its limited storage capacity, a portable computer needs some mechanism to move information into and out of itself. The HP 110 provides two avenues for moving data: the Hewlett-Packard Interface Loop (HPIL) described below and a terminal-emulation program called Terminal.

(continued)

AT A GLANCE

Name
HP 110, aka The Portable

Manufacturer
Hewlett-Packard Co.
3000 Hanover St.
Palo Alto, CA 94304
(408) 257-7000

Components
Size: 13 inches wide, 10 inches deep, 2⅞ inches high when closed (33 by 25 by 7.3 cm)
Weight: 9 pounds (4.1 kg)
Processor: 80C86

Memory
272K bytes of CMOS static RAM, 384K bytes ROM

Display
480- by 128-pixel liquid-crystal display, dot addressable, formatted as either 12 or 16 lines high and 80 characters wide

Keyboard
Full size, 76 keys with sculpted keytops

Storage
RAM can be partitioned to provide from 44K to 176K bytes of electronic disk, ROM treated as read-only electronic disk

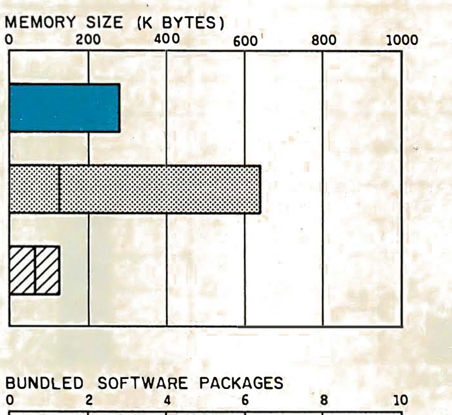
Expansion
One RS-232C port, one HPIL port, built-in 300-bps direct-connect modem

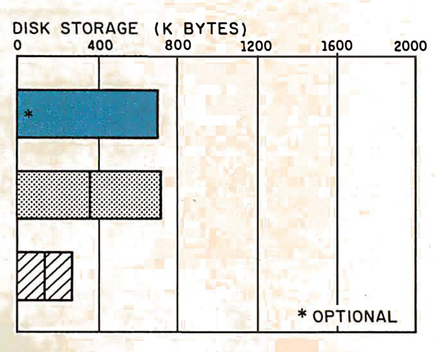
Software
Personal Applications Manager (PAM), Lotus 1-2-3, MemoMaker, Terminal, MS-DOS 2.11, HP Link, Diagnostics

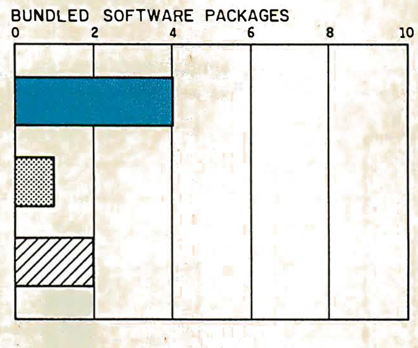
Price

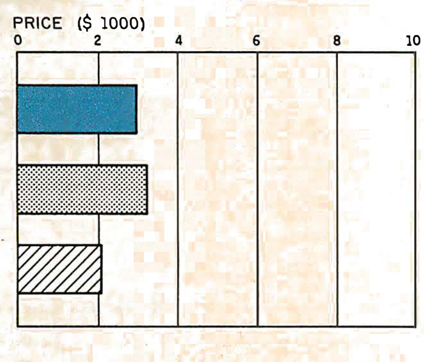
HP 110 with case:	$2995
Optional HP 9114 disk drive:	$795
Optional Desktop Link:	$150









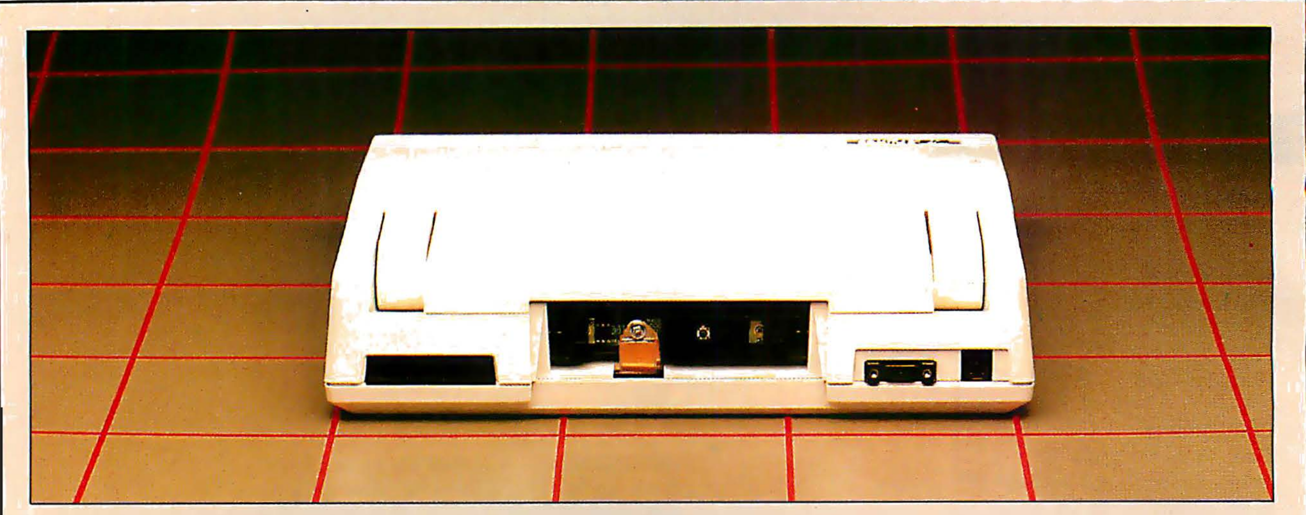








The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity for a single disk drive and the maximum capacity for each system (the HP 110 supports up to eight disk drives). The Bundled Software graph shows the number of software packages included with each system. The Price graph shows the list price of a typical configuration for each system: two floppy-disk drives, a monochrome monitor, graphics and color display capability, a printer port and a serial port, 256K bytes of memory (64K for 8-bit systems), the standard operating systems, and the standard BASIC interpreters. Note that the price of the HP 110 does not include a floppy-disk drive or a BASIC interpreter.



The rear panel of the HP 110: From left to right are the HPIL's in and out ports, the AC recharger connector, the battery compartment (usually covered), the serial port, and the modem phone jack.

DISK ACCESS IN BASIC (SEC)
250
200
150
100
50
0
19.2 41.8 56 37
9.2 28.1 46 36
WRITE
READ

BASIC PERFORMANCE (SEC)
250
200
150
100
50
0
114 191 245
37.7 69 94
SIEVE
CALCULATIONS

SYSTEM UTILITIES (SEC)
50
40
30
20
10
0
NA 9.6 22.9
5.8 44
40K FORMAT/DISKCOPY
40K FILE COPY

SPREADSHEET (SEC)
25
20
15
10
5
0
5.2 14.4 8.1 18
2 10.5 21.9
LOAD
RECALCULATE

HP RAM DISK
HP FLOPPY
IBM PC
APPLE IIE

The Disk Access in BASIC graph shows how long it takes to write and read a 64K-byte sequential file to both the electronic RAM disk and the floppy-disk drive. The BASIC Performance graphs show how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations column shows how long it takes to do 10,000 multiplication and division operations using single-precision numbers. The System Utilities graph does not include columns for Format/Disk Copy because the HP 110 had only one floppy-disk drive. The File Copy columns show how long it takes to transfer a 40K-byte file using the system utilities. The Spreadsheet graph shows how long the computers take to load and recalculate a 25-by 25-cell spreadsheet where each cell equals 1.001 times the cell to its left. The HP 110 used Lotus 1-2-3 both in ROM and on a floppy disk. The IBM PC and the Apple IIe used Multiplan.

Terminal is a nice little communications package. It features many of the capabilities you'd expect to find only on desktop computers. Terminal can auto-dial and auto-answer the phone, automatically log you onto the host system, and transfer files using several error-checking protocols including Modem7. It is also easily configurable.

The basic operation of Terminal revolves around the use of three screens: the terminal-, upload-, and download-configuration screens. The screens determine how Terminal will function. They are accessed by pressing a function key for each screen from the main menu. You can establish many configuration screens and swap them in and out as necessary, depending on your particular requirements. The terminal- and download-configuration screens are shown in photo 4. The upload screen is identical to the download screen except for the absence of the overwrite field.

The terminal-configuration screen sets up the communications parameters. You enter the data rate, number of data bits, and parity, as well as the communications channel you wish to use (modem, RS-232C, or HPIL). The built-in modem supports only data rates of 300 bps and below, but the RS-232C and HPIL ports can handle up to 19,200 bps. Even the end-of-line character can be defined as either CR, LF, or both. Another field is provided to label the configuration for future identification. If appropriate, you can also enter a phone number to dial, including commands for access pauses, answer or originate mode, and tone or pulse dialing, and an automatic log-on string.

Automatic log-on is accomplished by using a small programming language to create a log-on string. An E transmits the currently defined end-of-line character, a W followed by a number indicates a pause, a string in quotation marks is transmitted literally, and a string in curly brackets specifies a prompt to wait for from the host. If the log-on string is too long to fit on the single-line field of the configuration screen, it can be placed

(continued)

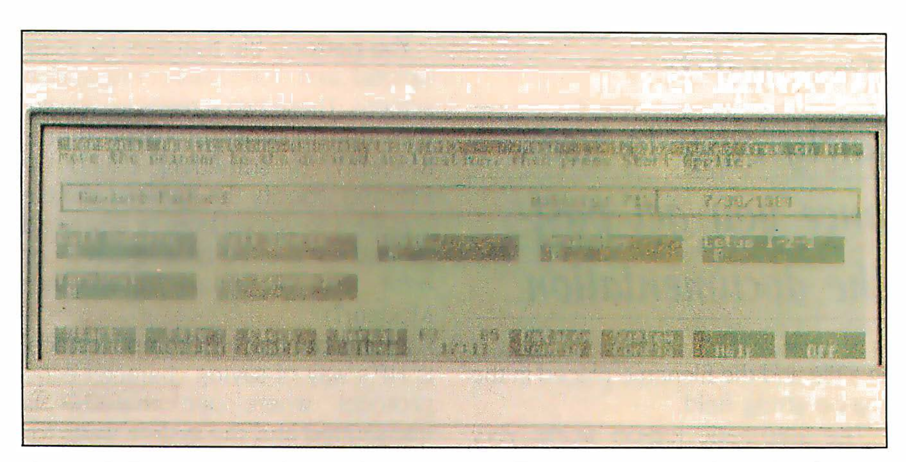
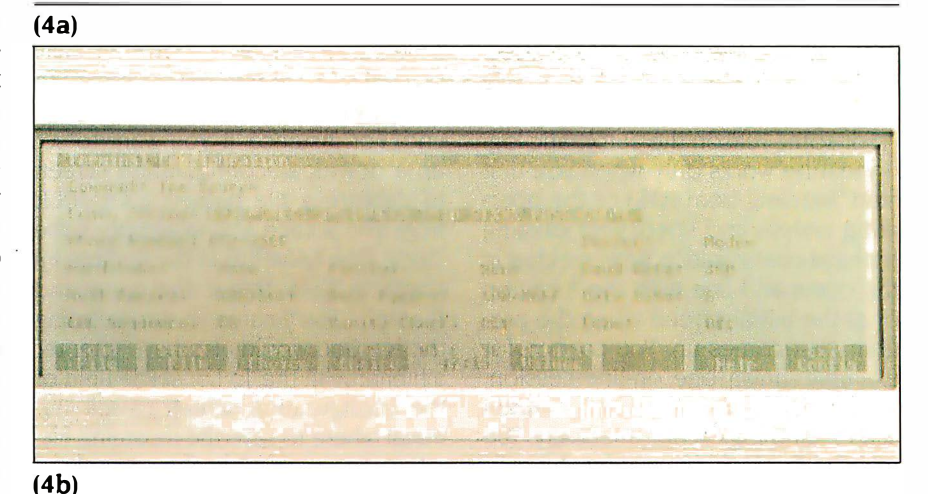


Photo 3: *The main PAM screen lets you access the installed applications. The first three boxes show applications I installed, two of which are turnkey log-ons to remote computer systems. The screen also provides information on the remaining battery charge and the number of bytes free on the internal electronic disk. The bottom row shows other options such as the system-configuration screen, setting the clock, and the file manager.*

(4a)



(4b)

Photo 4: *Configuration screens are the core to the built-in terminal-emulation software. The terminal-configuration screen (a) sets up the communications parameters, and the download-configuration screen (b) establishes how file transfers will take place. A similar upload screen does transfers in the opposite direction.*

Terminal is fairly easy to use once you get past the documentation.

in a file and the filename placed in the log-on string field.

The automatic log-on works very well with The Source. But with some slower systems (like the hundreds of individual bulletin boards around the country), you might encounter difficulties due mainly to the speed at which data is sent from the HP 110. The automatic log-on system has no provision for small delays between characters on the order of 70 milliseconds or so, which would probably solve this problem.

For some reason the automatic log-on feature works only when you first start Terminal from PAM or the operating system and specify an existing terminal-configuration screen either in the command line with the /t option or at the initial screen when the program first comes up. You cannot, for example, finish one on-line session, load another terminal-configuration screen, and log on automatically. Terminal will dial the phone for the next session but will not proceed with an automatic log-on even though a log-on string is included in the configuration. You must exit Terminal and reenter it, this time specifying the new terminal-configuration screen.

While this might not be a major shortcoming for commonly called systems (these would usually be installed in PAM as described below), it does get annoying when you first try to establish a workable log-on string. It means entering a log-on string, saving the configuration screen, exiting Terminal, reentering Terminal with the configuration screen specified, trying the automatic log-on, revising the log-on string if necessary, and repeating the whole procedure over and over until the log-on string works.

You perform file transfers by using upload- and download-configuration screens. These two screens let you set the transmission protocol (none, Modem7, or something called HP Prompt), specify the name of the file you want to upload from or download to, and set the file type, either 7- or 8-bit text or binary (used with Modem7).

It turns out that HP Prompt protocol is HP's way of saying character-echo protocol, where one character is transmitted and the system waits for the character to echo back before sending the next character. This is useful when you transmit to slow bulletin-board systems.

Next is something called a Remote Invocation field. The string you place in this field will be automatically transmitted to the host as soon as you start a file transfer. In this field you typically place the last command necessary to start the file transfer from the host end. For instance, if you want to set up a download-configuration screen to capture a file named EXAMPLE from The Source, you would place the string TY EXAMPLE in the Remote Invocation field; this is the command that tells The Source to start sending the file. You would also have to enter a filename in the To Local File field of the configuration screen to tell Terminal where to save the incoming file.

For some reason the download screen contains a From Remote File field and the upload screen contains a To Remote File field. The functions of these fields are unclear from the documentation. I can understand the need to tell Terminal which file to send from the HP 110 to a remote computer and what to name a file on the HP 110 being received from a remote computer, but I don't know why you would have to tell Terminal the names of the files on the remote computer. I left these blank and everything worked fine.

The last field is the Command Options field. This appears to be an extension of the Remote Invocation field, as the manual says it is transmitted after the Remote Invocation field. This, too, is not very clear. Does Terminal send an end-of-line sequence after each field? I left this blank also.

After you enter all the parameters, you can copy the configuration screen to disk by using the electronic A: drive of the HP 110. When you exit the configuration screen setup, it becomes "active," and the parameters it contains determine how Terminal will act. By combining terminal-, upload-, and download-configuration screens, you can customize Terminal for each system you call. Then from MS-DOS you enter the command line

```
TERMINAL /T TSOURCE.CFG /D
DSOURCE.CFG /U USOURCE.CFG
```

This line loads Terminal and the three configuration files you designed for (in this case) The Source. But you have an even easier way. You can install commonly used command lines directly into PAM and label them with the name of the system they call. Then from the PAM screen you merely have to select the label you created from the menu and press one key. The rest is automatic.

Terminal can also be set up for auto-answer. According to the user's manual, you can configure the HP 110 to let a remote terminal (or computer) control it. When the phone rings and the HP 110 is in PAM, the computer looks for a file named AUTOANSR.BAT. If it finds it, the contents of that file are executed as with any other batch file. By just calling your computer, you can have it execute a predetermined set of commands. This opens up many possibilities for remote data logging, security, and other functions.

Terminal is a fairly easy program to use once you get past the documentation. I found many of the explanations confusing, and in some cases rather incomplete. The explanations of uploading and downloading were particularly sparse, especially in their descriptions of how the upload- and download-configuration screens affect these procedures. It was only through experimentation that I finally figured them out.

(continued)

TRANSTECTOR Has A Better Way To Eliminate Computer Malfunctions.



In spite of the few complaints mentioned above, I found Terminal to be more than adequate. The inclusion of Modem7 protocol struck me as so unusual from a company like Hewlett-Packard that I have to think they are serious about personal computers.

DISKS: ELECTRONIC AND OTHERWISE

The HP 110's memory has a unique structure. The ROM portion of memory, fixed at 384K bytes, is treated like a disk drive by the operating system. Designated the B: drive, the ROM contains nearly all the software you are likely to need, including Lotus 1-2-3, Terminal, MemoMaker, PAM, and MS-DOS. Anything else you care to add would reside in the RAM portion of memory.

The CMOS RAM in the HP 110 is partitioned into two parts. One section is reserved for program and data-file storage and is referred to as the A: drive. The other section is considered main memory, but the partition is movable. You can designate anywhere from 96K to 228K bytes of the total 272K bytes of RAM to be main memory in 4K-byte chunks. The balance, 176K to 44K bytes, is reserved for the electronic A: drive. The partition can be moved at any time, and the system will protect any files that exist on the A: drive by not letting you move the partition any further in that direction.

When you select one of the programs stored on the B: drive (ROM), such as Lotus 1-2-3 or Terminal, you do not lose any of the main RAM memory to holding the program itself. Thus, when using a program like Lotus 1-2-3, you have all the available main memory for your worksheet. Programs and data stored on the A: drive are loaded into main memory, just like from any other type of disk drive.

In addition to the two electronic disk drives in the HP 110, you can add up to eight external disk drives using the HPIL. (For a brief description of the HPIL, see "An Introduction to HPIL" on page 300.) I was able to test the HP 9114 disk drive, shown in photo 5, which is a double-sided, 3½-inch Sony drive that can hold 684K bytes of data. If you consider the heavy system-file overhead of the HP 150, these disks provide the HP 110 with nearly four times the storage capacity of the HP 150's disks. The HP 9114 can read from and write to disks formatted on the HP 150. Access times for data on this external drive are not bad at all, especially considering the constraints of the HPIL. They compare very favorably with those of the IBM PC.



Photo 5: *The* HP 9114 *portable disk drive contains a* 3½*-inch, double-sided* Sony *disk drive capable of storing over* 680K *bytes of data.* Also *included is a lead-acid battery and interface electronics.*

The HP 9114 is also battery powered, which accounts for the size of the unit: 11½ inches wide, 8 inches deep, and 3 inches high. That's about the size of the 5¼-inch disk drive for the Commodore 64 computer. When the battery starts to wear down, a light flashes on the front of the unit, and if the unit isn't recharged, it starts getting flaky. The disk drive will not start working again immediately when the charger is plugged in. You must wait for the battery to be sufficiently recharged.

THE PORTABLE-DESKTOP LINK

Besides the communications link offered by terminal emulation, HP has developed a more direct means of connecting the HP 110 to another computer. Called the Portable-Desktop Link (or just the Link), this method turns your desktop computer, either an IBM PC, PC-compatible, or HP 150, into a peripheral of the HP 110. I tested this link, also called the extended I/O (input/output) accessory, with the HP 150.

The Link is a combination software/hardware package retailing for $150. An interface card plugs into the desktop and connects the computer as a peripheral device on the HPIL with the HP 110 as the controller. The software supports the HPIL capabilities and determines what function the desktop will perform. When connected to the loop, the desktop becomes three peripherals in one: a mass-storage device, a printer, and a display. However, you can use only one function at a time, and this is controlled by a single keystroke on the desktop's keyboard.

To use the Link, you install the interface card in a peripheral slot in the desktop like any other card. Next, the two-wire HPIL cable is used to connect all the devices in the loop together. Where in the loop the desktop is connected is determined by what other devices exist in the loop. Then you run the software that comes with the Link on the desktop computer, which is now a peripheral of the HP 110. Finally, you must reconfigure

(continued)

An Introduction to HPIL

HPIL is an interface system defining the way stand-alone, desktop, and hand-held devices can work together. The characteristics of HPIL are formally defined in the HPIL reference specification. This specification defines both a physical link and a message protocol between a number of devices and controllers.

HPIL systems can comprise three types of devices: talkers, listeners, and controllers. Talkers send data over the interface loop. Listeners receive data from a talker or commands from a controller. Devices can be both talker and listener, such as a printer that receives data to print (listener) and sends out status information (talker). The role of talker or listener is assigned to a device by a controller.

Controllers are in charge of all loop operations. They are typically responsible for assigning addresses to devices, assigning device roles (talker, listener, or controller), servicing device requests, and initiating the transfer of data from talker to listener(s). Only one controller can take control of the loop at any one time, although several can be physically connected to it and pass control from one to the other.

The HPIL specification allows for a maximum distance of 10 meters between devices using simple two-wire cable. Distances of up to 100 meters can be achieved with the use of shielded twisted-pair cable.

HPIL supports a maximum of 31 devices on a single loop using the standard method of addressing. An extended form of addressing supports up to 960 devices. Theoretically, data can be transferred over the loop at rates up to 20,000 bytes per second, but with current devices rates of only 2000 bytes per second are much more common.

Hewlett-Packard has defined a message structure: a common set of messages that all HPIL devices must understand. These messages define the way a device must operate to communicate over the loop. Each message comprises 11 bits: 3 bits of control information followed by 8 bits of data or command. This 11-bit message travels over the loop from controller to device or from talker to listener, with the most significant bit of control information arriving first. Since messages on the loop can arrive at any time, the first bit to arrive at a device acts as a start bit. It also signals whether the message contains data or a command.

HPIL messages are divided into four basic classes or major types: Command class, Data or End class, Ready class, and Identify class. These classes are based upon the coding of the message's 3 control bits.

The Command class includes all messages sent from the active controller to other devices on the loop. These messages contain commands that control either interface or device functions. Instructions in the Command class can pertain to a single device or to all devices residing on the loop.

A device receiving a Command class message immediately retransmits the message to the next device on the loop and saves its own copy of the command before beginning execution. The active controller must follow the Command class message with a Ready For Command message to verify that the device has completed command execution.

Messages in the Data or End class include all data sent from an active talker to an active listener. The last byte of data in a record is called the end byte.

Ready class messages control loop operation. Three subgroups of messages are within the Ready class: the Ready For Command message, the group of messages known as the Addressed Ready group, and the group of Ready frames called the Auto Address group. The Ready For Command message lets the active controller determine when devices have completed execution of a prior command. Addressed Ready commands normally are used to control sending data from talker to listener. Auto Address messages simply let a controller bring up or configure a loop without operator intervention. In this mode, devices are effectively assigned addresses through the use of messages in the Auto Address group.

Identify class messages are used by the controller to determine whether a device on the loop needs servicing. The process of identifying which device needs attention is called polling. The HPIL command structure allows for two methods of polling: serial and parallel.

See table A for a list of HPIL peripherals that work with the HP 110.

[*Adapted from* The HP-IL System: An Introductory Guide to the Hewlett-Packard Interface Loop, *by Gerry Kane, Steve Harper, and David Ushijima. Copyright* 1982 *by* McGraw-Hill Inc. *Used by permission.*]

Table A: HPIL *peripherals that work with the* HP 110. *Other* HPIL *peripherals, such as interfaces to scientific instruments, require special device-driver software that is not included with the computer.*

Mass Storage
HP 9114A double-sided microfloppy drive
HP 82161A digital microcassette drive

Printers
HP 2225B (ThinkJet) ink-jet printer
HP 82905B 80-column impact dot-matrix printer
HP 2671A 80-column thermal printer
HP 2671G 80-column thermal graphics printer

Plotters
HP 7470A two-pen graphics plotter

Displays
HP 82163B 32-column video interface
Mountain Computer MC00701A 80-column video interface

Interfacing/Communications
HP 82168A acoustic coupler modem
HP 82973A HPIL card for the IBM PC XT
HP 45643A extended I/O accessory for the HP 150
HP 82164A HPIL/RS-232C converter
HP 82169A HPIL/HPIB converter

the HP 110 to tell it that additional disk drives are available on the loop, and perhaps a printer, too.

Once this is done, the desktop computer's disk drives become the HP 110's. That is, the A: and B: drives of your IBM PC or HP 150 become the C: and D: drives of the HP 110. If an HP 9114 disk drive is already installed in the loop as the C: drive, the desktop's A: and B: drives become the HP 110's D: and E: drives. If your desktop has a hard disk, it also becomes part of the HP 110. If a printer is attached to your desktop, you can print from that. Finally, you can print to the desktop's display. The desktop's display, however, does not substitute for the HP 110's.

Should you happen to want to exchange data with another HP 110, all you need is already built into the HP 110. A version of the Link software is supplied in the HP 110's ROM, though not listed on the PAM menu, and the HPIL port is also included. Just connect up the cables and you're set.

The Link is a cost-effective addition to the HP 110 for those already owning a complete desktop system. It precludes buying a separate printer for the HP 110. It gives the HP 110 access to your desktop's mass-storage system, making the exchange of data rather straightforward; you merely copy the files from one disk drive to another using the Copy command.

BENCHMARKS

After experiencing the performance of the HP 150, I didn't expect any remarkable times from the HP 110. However, the HP 110 proved to be a formidable machine. The BASIC benchmarks shown in the "At a Glance" box were performed with the same BASIC-86 used to perform them on the HP 150. Since the HP 9114 disk drive can read the HP 150 disks, and since BASIC-86 is a generic MS-DOS BASIC, I had no problems in transferring it over to the HP 110.

Where applicable, I performed benchmarks using both the electronic A: drive and the HP 9114, which was the C: drive, for comparison. In most cases, test results for the electronic disk were 55 to 65 percent faster than the same tests run using the floppy disk. Another point not shown in the benchmarks is the consistency of times achieved using the electronic disk. While floppy-disk times varied from trial to trial by as much as 25 percent, times for the electronic disk rarely varied more than a tenth of a second.

I did not perform one of the two system utility benchmarks. Disk Copy requires that both disks be the same format, as it is a track-by-track copy program. Unfortunately, I have only one external disk drive, and it is formatted differently from the internal electronic disk drive. It appears that Disk Copy can only be used between two external disk drives. If this is the case, I don't understand why Disk Copy is included in the ROM and the Browse function of the file manager is left out.

The file-copy benchmark was performed using the Copy command to move the standard 40K-byte text file from the electronic A: drive to the external floppy disk.

Just to get an idea of how the HP 110 can handle word-processing tasks, I obtained a prerelease copy of WordStar for this machine and compared it to results BYTE has obtained with the IBM PC running WordStar version 3.3 and BYTE's standard 4000-word document. Of course, the electronic disk (A:) allowed very fast document loads and saves (6.1 and 11.1 seconds) compared to the IBM PC (9.9 and 24.9 seconds), but even the HP's floppy disk (C:) scored respectable times (7.8 and 26.1 seconds). Likewise, the search test results for the RAM drive and floppy were comparable with the IBM PC (8.5 and 19.1 seconds versus 10.5 seconds). The only major difference was in the scroll test (195 seconds versus 41.2 seconds for the IBM), due to the slow speed of the LCD. These times were obtained with a prerelease version; the final version might be a bit faster or slower.

I had one problem with WordStar that probably will not change from version to version, and that has to do with the size of the RAM drive. When

The HP 110 *performed better than the* IBM PC *in most benchmarks.*

all of WordStar is loaded onto the electronic disk, only about 64K bytes is left for documents, not counting any memory used by other programs. Also, WordStar usually makes three copies of a document: the original, a backup copy, and a temporary copy WordStar is working on. This can quickly eat up the memory in the RAM drive. You might have to delete all the backup files to save space.

CONCLUSIONS

The HP 110 performed better than the IBM PC in most of the benchmarks, especially when taking advantage of the electronic A: drive. The HPIL, the RS-232C port, the built-in modem, and the optional Portable-Desktop Link provide a flexible system that can be easily expanded and allows easy exchange of data.

Built-in software provides most of the functions most people will need. The terminal-emulation software supports Modem7 protocol, MemoMaker provides adequate word processing, and Lotus 1-2-3 provides powerful business tools. Unlike its predecessor on the HP 150, PAM works. This implementation of the MS-DOS shell actually makes using the machine easier.

All this is contained in a portable package you can use while traveling, not just when you get to your destination. The optional HP 9114 disk drive and the ThinkJet printer are battery powered for portable use, too.

The ads for the HP 110 depicted it as the sports car of computers, driving circles around the lumbering desktops (too bad one of them wasn't the HP 150). They implied that the HP 110 is both highly portable and more powerful than the desktops. Perhaps they're right. ■

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This little critter comes w th specially-designed software that flies through the maze of keystrokes on the most popular business programs faster than you can say "cheese."

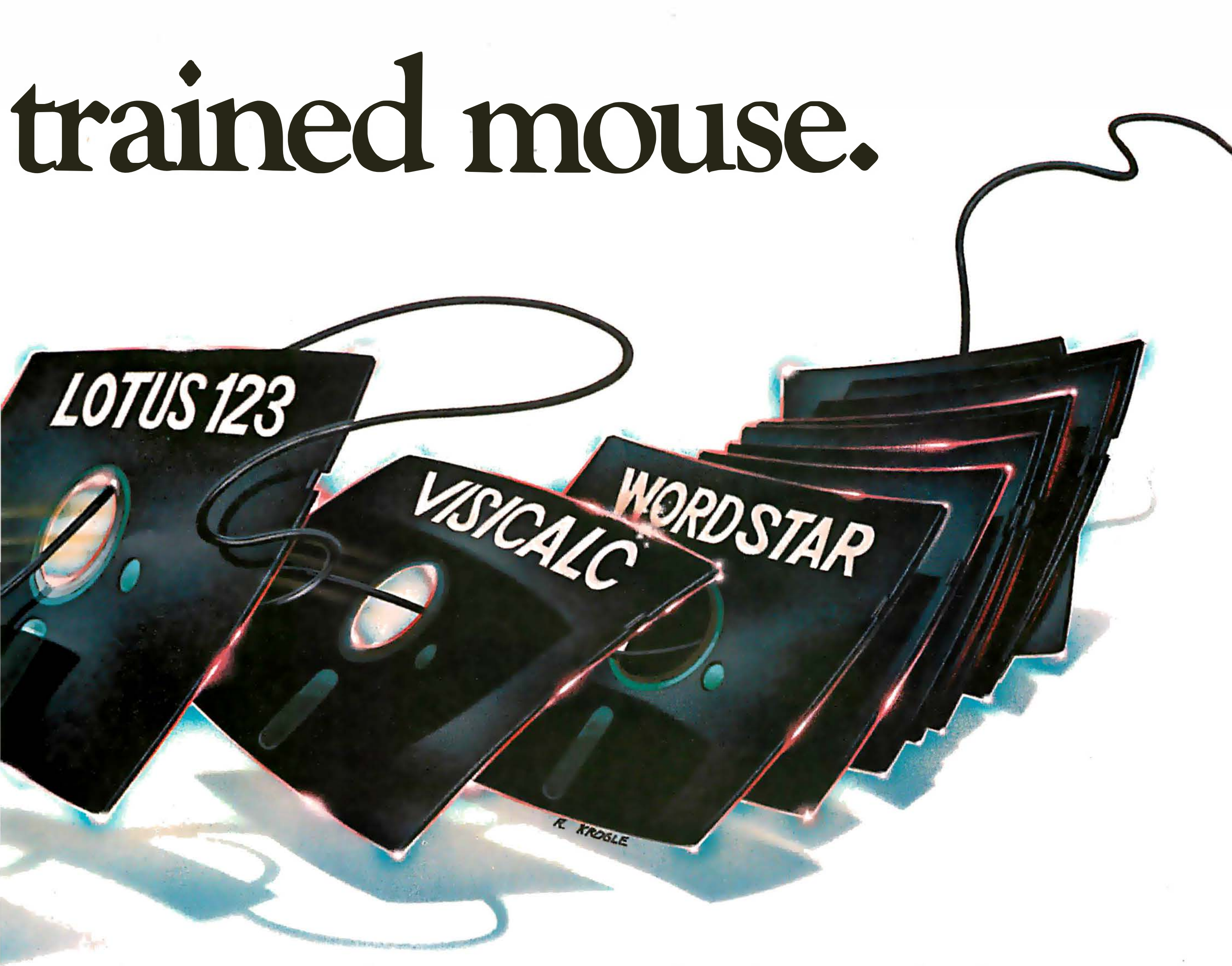
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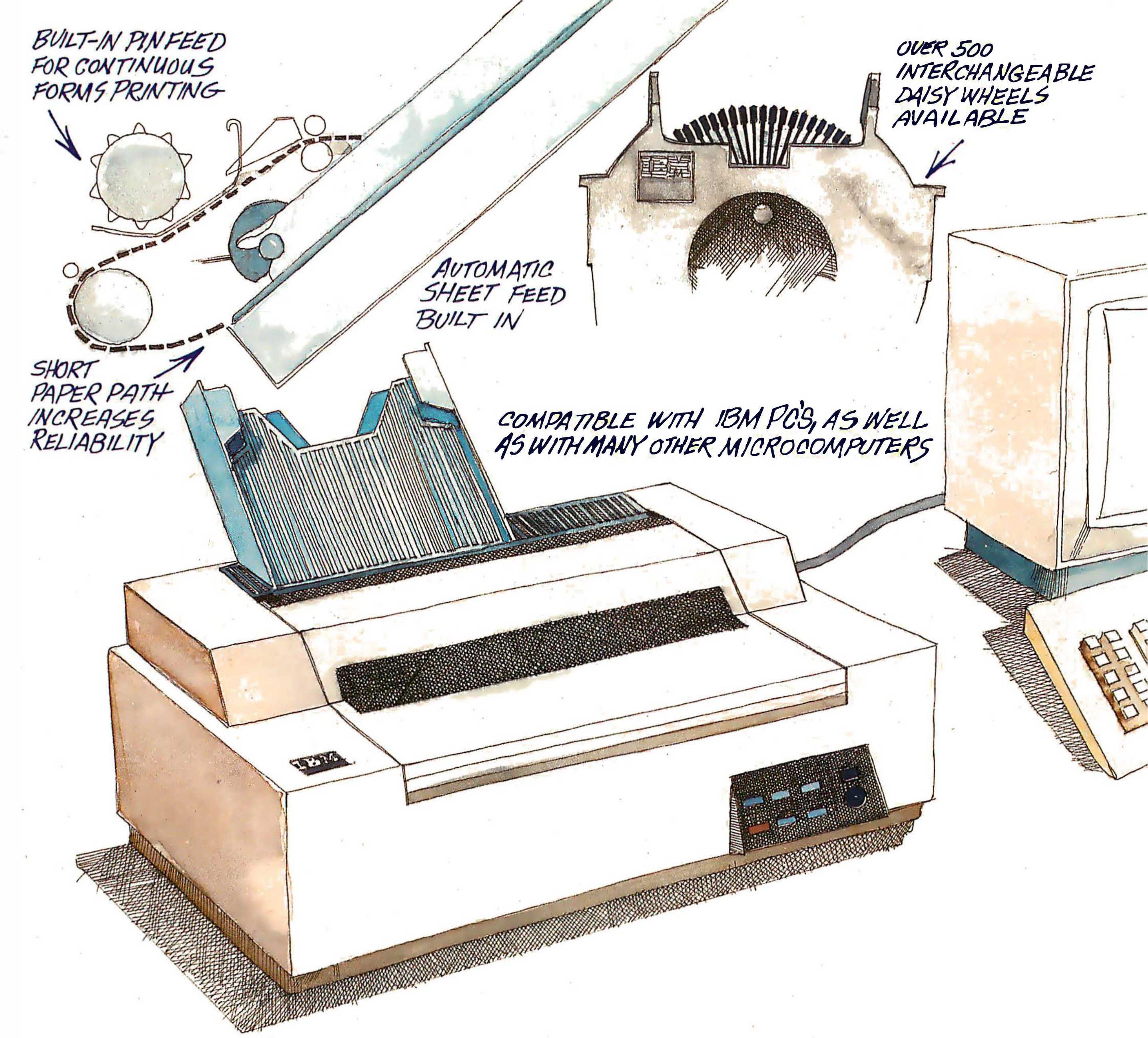
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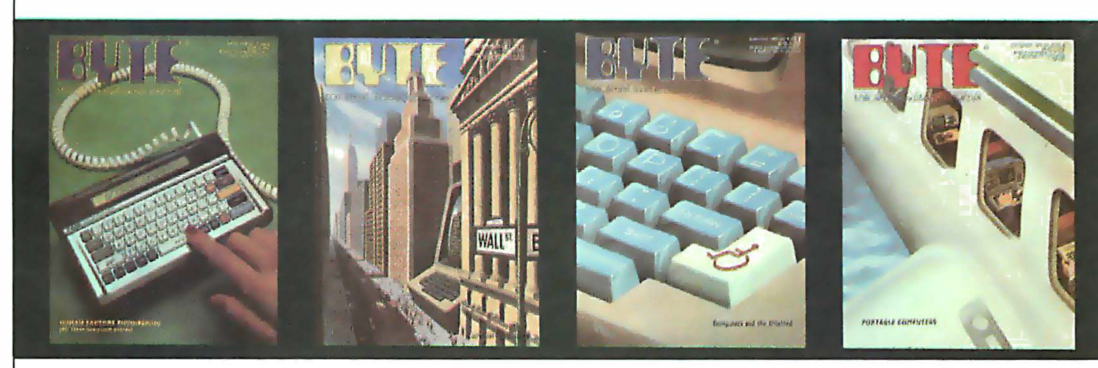
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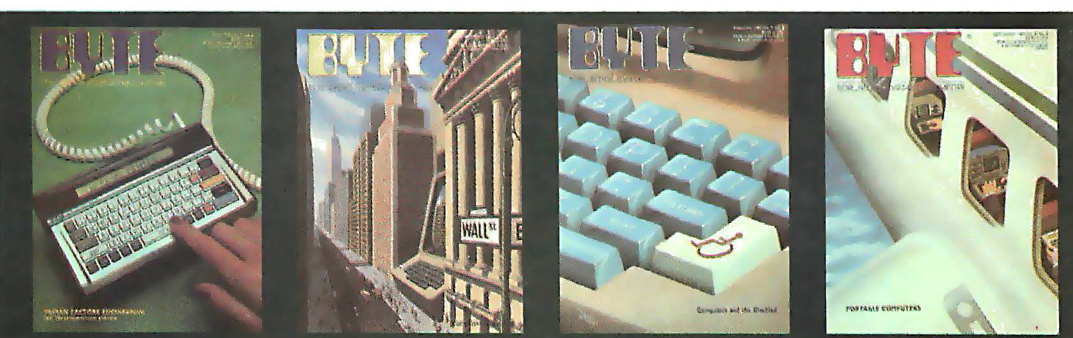
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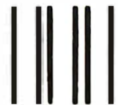
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Gifford's MP/M 8-16

Here's a no-nonsense S-100 system

BY CHARLES H. STROM

Contrary to commonly expressed views, the S-100 bus is still very much alive. One study predicted a 40 percent growth in 1984 sales of S-100 systems. More than half the sales of S-100 systems and board-level components are attributed to CompuPro. Several years ago, it became apparent that CompuPro would do better to establish a dealer network rather than provide end-user support. One of the earliest authorized CompuPro System Centers was Gifford Computer Systems. In this review I examine a system that has been developed by Gifford based on CompuPro hardware and Gifford's own operating system (OS), known widely as MP/M 8-16.

HARDWARE

Gifford's MP/M 8-16 system is built around an S-100 mainframe and CompuPro circuit cards. A typical system consists of a 20-slot mainframe cabinet, dual Qume 842 double-density double-sided 8-inch floppy-disk drives (for a storage total of 2.4 megabytes), and a privately labeled and packaged Winchester hard-disk drive.

Gifford has researched the rapidly changing Winchester market and has offered the CompuPro Disk 2 and Disk 3 controllers, Morrow controllers, Konan controllers, and a wide variety of drives. The systems used in this review are based upon the Konan DGC-100 ("David") controller interfaced to an ST-506–compatible Ampex Pyxis hard-disk drive (manufactured by Rodime), offering a formatted capacity of 21 megabytes. This controller/drive combination has rather conservative specifications in terms of speed but has been found by the Gifford staff to be extremely trouble-free.

A typical three-user system is equipped with 320K bytes of memory. The OS itself requires 64K bytes for a basic system, and a 32K- or 64K-byte hard-disk cache (which is automatically flushed every 30 seconds or when a SYNC command is issued) also eats into the basic memory inventory. It quickly became apparent that there is no such thing as too much RAM (random-access read/write memory); I have 448K bytes in a four-user (plus modem line) system. Up to nine serial devices are accommodated by the CompuPro System Support and Interfacer 3 boards, and Gifford can configure systems with more serial ports.

The system supports four TeleVideo 950 terminals, a Diablo 630ECS printer, an Okidata Microline 82A printer, and a Racal-Vadic 3451 modem. Total RAM in the system determines how many devices may be used simultaneously as, of course, do the particular applications being executed at any time. I could thus add two additional terminals, though it is unlikely there is enough memory to support simultaneous operation of all consoles.

Gifford sells and supports the TeleVideo 925 and 950, the Freedom 200, and the GCS 80 terminal (manufactured by C. Itoh and privately labeled by Gifford). I've had no problems running any "atypical" terminal (such as the Zenith Z-29 I use on my MP/M 8-16 system at home).

CompuPro's M-Drive/H board, a popular option for the system, is a 512K-byte RAM-disk emulator. This board is integrated into MP/M 8-16 as drive N:, or it can be optionally made the A: drive using Gifford's SWAP command. The advantage of the latter approach is related to a feature of generic MP/M-86 that allows global access to any files on drive A:, USER 0 that have the SYS attribute set. Thus, you can place commonly used executable files, such as STAT.CMD, DIR.CMD, WS.COM and its overlays, on drive A: as SYS files and enjoy a significant speed advantage.

Normal system RAM can be partitioned at cold boot to be a pseudodisk (in this case drive M:), but there is no SWAP command to convert M: to A:.

BOOTING MP/M 8-16

The system is designed to run continuously; in fact, with the advent of version 2.1G,

(continued)

Charles H. Strom, director of laboratories at New York University (Department of Chemistry, 4 Washington Place, New York, NY 10003), is a chemical physicist by training and a computer user by choice.

Gifford supplies utilities to make the OS easy to use.

I have not needed to cold-boot the system for many weeks. In any case, it is not a terribly tedious process to boot up an MP/M 8-16 system. A floppy loader disk contains a bootstrap on the system tracks, and MPM.SYS, the actual OS image, is the only required file in the directory. Once booted, the hard disk is partitioned into several logical drives (A:, B:, and C: in my case), while the 8-inch floppy-disk drives are D: and E:. My single 5¼-inch floppy-disk drive (which requires a separate Disk I controller) is drive F:, and the M-Drive/H is N:. The 5¼-inch floppy-disk drive can read/write/format IBM- (CP/M-86) and Morrow-format disks. Gifford was having some trouble supporting double-sided 5¼-inch floppy disks at the time I obtained a single-sided add-on.

After loading MPM.SYS, the OS searches drive A: for several initialization files. MPMINIT.SUB is a SUBMIT file configured by the user for his particular system characteristics. When MPMINIT.SUB terminates, you can optionally execute a command, MPMINIT.CMD, go into multiuser mode, activating all terminals with a user-alterable banner and a NAME: prompt.

System Security

Gifford apparently has devoted a great deal of effort to system security, particularly in recent updates of its OS. The company has produced a reasonably secure system. It is possible to configure MP/M 8-16 with no security, a moderate level of security, or a relatively high level of security. Most users will opt for the middle route since it offers a good deal of safety without taxing the resources of the hardware to the point of significantly reduced throughput (every added security measure results in increased system overhead).

A PASSWD file has an entry for each user permitted on the system; security features also include two related utilities, NEWUSER.CMD and PASSWORD.CMD. NEWUSER.CMD is a program accessible only by the system manager (who must log in as SYSTEM with a unique password to use this program). It allows addition of new users to the PASSWD file; entry of an initial password for each user; default drive selection for each defined user upon logging in; accessible user areas; and default selection for printers, terminals, etc. The system manager can lock a user into a particular user area (or areas) or even into a particular 8- or 16-bit program. A user profile in the PASSWD file can thus be configured so that a person, upon logging in, is automatically shunted into WordStar, for example, and upon exiting from the program is logged off the MP/M system. Gifford uses this feature on a system in its offices with modem access. A customer may log in with the name MESSAG (no password is needed), and the message program is automatically executed, letting the customer leave communications for any of the Gifford staff.

The PASSWORD utility lets a user change his password at any time. Even the system manager does not have knowledge of individual passwords. In fact, since they are encrypted, there is no way to retrieve them. If a user forgets his password, the system manager can delete the entry in the PASSWD file and a new one can be added.

My major complaint with the security features of MP/M 8-16 is that there is no time-out function to automatically log out a user if there is no console activity for a certain time period. This makes it possible to hog system resources by logging in early in the morning and never logging out, even when not using the system. Also, since modems are typically used as consoles on MP/M 8-16 systems, a serious security flaw exists if a legal user is disconnected prematurely or neglects to type LOGOUT to exit the system before terminating the call. If an unauthorized party were then to call the system, he would be logged in under the legal user's PASSWD profile and could cause trouble. In addition, it would be convenient if the manager could force a user off the system.

System Utilities

Once you are logged on to the system, you can execute several files (such as LOGIN.SUB and LOGIN.CMD). All of the well-known MP/M-86 utilities are available, and since they are well documented in the Digital Research literature, I will not go into them in any detail. Gifford has added considerable functionality, however, in the form of new utilities. A prime example is the ability to run 8-bit software. With rare exceptions—some programs that perform direct BIOS (basic input/output system) calls—you can use the 8085 on the CompuPro dual-processor board to full advantage. Suppose I type WS FU.BAR at the system prompt. The OS looks for WS.CMD; if it finds it, the OS executes the command line normally. If it doesn't find it, the OS searches for WS.COM; and if WS.COM is located, the OS parses the command line again (transparently to the user) to SW WS FU.BAR and executes this new command line. SW.CMD is a Gifford utility that sets up the 8085 with a 64K-byte block of contiguous RAM and simulates a CP/M 2.2 environment, complete with 62K-byte transient program area, the actual memory available to a CP/M 2.2 program. Since it lets you preserve your investment in 8-bit software while converting to 16-bit programs at a measured pace, this is clearly one of the outstanding features of MP/M 8-16. And, since the 8085 is directly executing the machine code at 6 MHz, there is no degradation of operation as might be observed with an 8080 emulator running on a 16-bit microprocessor.

Gifford supplies a number of utilities to make the OS easier to use: TOD displays system time and date (using the hardware-clock chip on the CompuPro System Support board);

(continued)

AT A GLANCE

Name
Gifford MP/M 8-16

Manufacturer
Gifford Computer Systems
2446 Verna Court
San Leandro, CA 94577
(415) 895-0798

Processors
8-bit 8085, 6 MHz; 16-/8-bit 8088, 8 MHz

Memory
64K minimum to 1 megabyte maximum

Storage
Standard configuration includes two 8-inch double-sided double-density floppy-disk drives (1.2 megabytes each); 5¼-inch floppy-disk drives and 5- to 74-megabyte hard-disk drives are optional

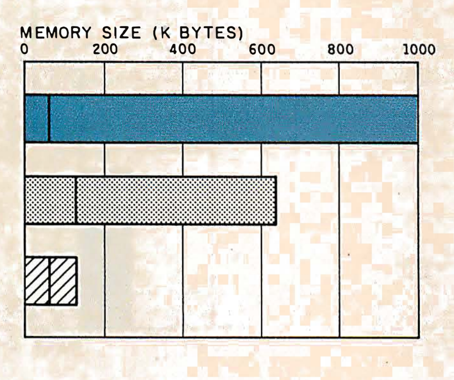
Expansion
System enclosure is a CompuPro desktop unit with 20 IEEE-696/S-100 slots

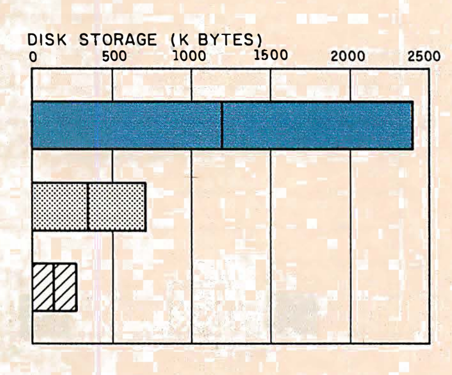
Bundled Software
CP/M 2.2, CP/M-86, Concurrent CP/M, dBASE II (8-bit version), SuperCalc-86

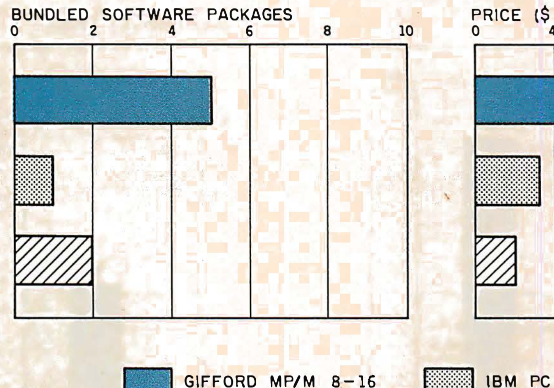
Optional Equipment
Hard disks: 5-megabyte, $1660; 21-megabyte, $2660; 37-megabyte, $3860; M-Drive/H RAM disk with 512K, $995; CompuPro 8086 CPU board, $495

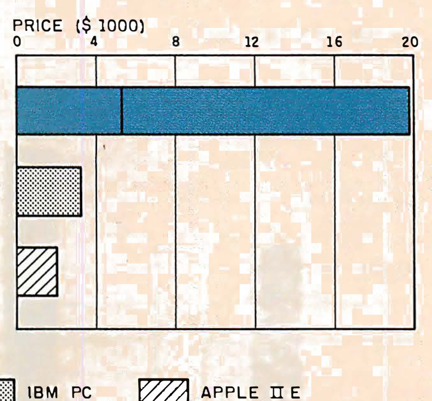
Price
Single-user system with two 8-inch floppy-disk drives and 64K RAM, $5330; eight-user system with two 8-inch floppy-disk drives, 1-megabyte RAM, 74-megabyte hard disk (two 37-megabyte drives), and additional user interface boards and equipment, $19,925



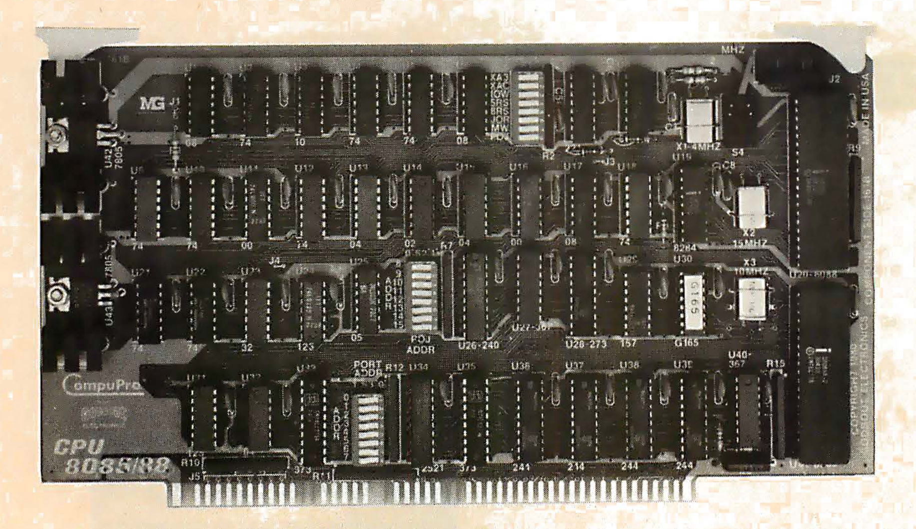








The Memory Size graph shows the standard and optional memory that's available for the computers under comparison. The graph of Disk Storage capacity shows the highest capacity for typical disk drives for each system. The Bundled Software Packages graph shows the number of software packages included with each standard system. The Price graph shows the list prices for a minimum, single-user Gifford MP/M 8-16 and also for the fully configured, eight-user system. This Gifford system is compared to systems with two floppy-disk drives, a monochrome monitor, graphics and color-display capability, a printer port and a serial port, 256K bytes of memory (64K bytes for 8-bit systems), the standard operating systems, and a BASIC interpreter for each system.



Gifford Computer Systems' MP/M 8-16 computer uses the CompuPro Dual Processor 8085/8088 board to run both CP/M-80 and CP/M-86.

DISK ACCESS IN BASIC (SEC)

	GIFFORD MP/M 8-16	IBM PC	APPLE II E
WRITE	28	56	37
READ	26	46	36

BASIC PERFORMANCE (SEC)

	GIFFORD MP/M 8-16	IBM PC	APPLE II E
SIEVE	112	191	245
CALCULATIONS	50	69	94

SYSTEM UTILITIES (SEC)

	GIFFORD MP/M 8-16	IBM PC	APPLE II E
40K FORMAT/ DISK COPY	23	9.6	23
40K FILE COPY	37	5.8	44

SPREADSHEET (SEC)

	GIFFORD MP/M 8-16	IBM PC	APPLE II E
LOAD	8	8.1	18
RECALCULATE	3	11	22

The graph for Disk Access in BASIC shows how long it takes to write a 64K-byte sequential test file to a blank floppy disk and how long it takes to read this file. (For the program listings, see the June BYTE, page 327, and the October BYTE, page 33.) The BASIC Performance graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. In the same graph, the Calculations results show how long it takes to do 10,000 multiplication and division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and copy a disk (adjusted time for 40K bytes of disk data). The Spreadsheet graph shows how long the computers take to load and recalculate a 25- by 25-cell spreadsheet, where each cell equals 1.001 times the cell to its left. The Apple and the IBM used Multiplan; the Gifford system used SuperCalc-86.

DOWN deactivates multiuser operation, aborting any tasks in process (and optionally executing DOWN.SUB); HISTORY is an optional file that maintains a complete chronological record of all commands submitted to the system; MOTD is a "message of the day" that is displayed upon logging in; SCHED schedules any command, program, or SUBMIT file to occur at a user-specified time; SETMEM defines the maximum memory block allocated to a 16-bit process; TIME is a program that can benchmark the duration of another program (and was used to record the BYTE benchmarks in this article; see table 1).

Several utilities are targeted toward the particular multiuser environment and deserve special mention. There is a sophisticated MAIL system modeled after the UNIX mail system, and WRITE allows real-time communication between users.

An exhaustive HELP facility provides on-line documentation of virtually all features of MP/M 8-16. HELP is fully documented, enabling a user to generate his own files and provide similar documentation for his own programs or processes.

Applications Software

The MP/M 8-16 system used in this review was bundled with an 8-bit version of dBASE II and a 16-bit version of SuperCalc. Apparently the CP/M-86 version of dBASE II is a poor performer, so this probably explains Gifford's furnishing this version. I also purchased a couple of software packages including WordStar and Spellguard (both 8-bit versions). Gifford is one of the few dealers that charges list price for such software. The company does deliver the MP/M 8-16 system with all purchased software (including applications and OS utilities) preinstalled on the hard disk, which saves the user considerable time and effort. Getting the computer running is essentially a plug-and-go operation.

One last product worthy of note is Modem 8-16, Gifford's proprietary communications utility. Modem 8-16 is one of the few communications programs that will run on an MP/M 8-16 system. It has a flexible and versatile user interface, supports script files, handles auto-dialing modems, unattended operation, and file transfer in conjunction with SCHED, and more. Modem 8-16 is one of the nicest communications programs I have seen. Its one serious deficiency is the absence of any error-checking protocol for file transfer. Modem 8-16 does transfer files with XON/XOFF handshaking, but it does not include the Christensen (XMODEM) or CIS (CompuServe Information Service) protocols. I have indications that the company will soon add error-checking file-transfer protocols to a new version of Modem 8-16.

Documentation and Support

In recent months, Gifford has made significant strides in improving its documentation of MP/M 8-16. In the

(continued)

Table 1: *Benchmark results for the Gifford MP/M 8-16 System. The BASIC benchmarks were determined using an 8-bit version of Microsoft BASIC 5.2. SuperCalc-86 version 1.0 was used in the spreadsheet benchmarks.*

Benchmark	System and Time
BASIC	
Sequential write	
—to single-sided single-density floppy disk	MP/M 8-16, 28 seconds CP/M-80, 27 seconds
—to hard disk	MP/M 8-16, 14 seconds CP/M-80, 12 seconds
Sequential read	
—from single-sided single-density floppy disk	MP/M 8-16, 26 seconds CP/M-80, 25 seconds
—from hard disk	MP/M 8-16, 14 seconds CP/M-80, 10 seconds
Sieve of Eratosthenes	MP/M 8-16, 112 seconds CP/M-80, 99 seconds
Calculate with single-precision numbers	MP/M 8-16, 50 seconds CP/M-80, 45 seconds
System Utilities	
Format and disk copy (including copy verification)	
—single-sided single-density (243K bytes)	MP/M 8-16, 38 seconds
—double-sided double-density floppy disk (1.2 megabytes)	MP/M 8-16, 23 seconds
Copy file (40K-byte, using PIP)	
—hard disk to single-sided single-density floppy disk	MP/M 8-16, 23 seconds
—hard disk to double-sided double-density floppy disk	MP/M 8-16, 13 seconds
—hard disk to hard disk	MP/M 8-16, 11 seconds
—single-sided single-density to single-sided single-density floppy disk	MP/M 8-16, 37 seconds
Spreadsheet	
Load spreadsheet	
—from single-sided single-density floppy disk	MP/M 8-16, 8 seconds CP/M-86, 10 seconds
—from hard disk	MP/M 8-16, 4 seconds CP/M-86, 6 seconds
Recalculate	MP/M 8-16, 3 seconds CP/M-86, 3 seconds

past, it could have been argued that someone with a "hacker" mentality should install and maintain the system; the documentation consisted of the not-uncomplicated Digital Research MP/M-86 manuals (not to be confused with the brain-damaged 2.2 manuals—the MP/M-86 manuals are far superior) and a thin 8-16 implementation manual containing much information that can only be described as extremely terse. Luckily, this deficiency has been addressed, and the new Gifford manual is a tremendous improvement. The MP/M 8-16 users manual is bound in an attractive "IBM PC-style" loose-leaf binder, consisting of hundreds of pages of clearly written and indexed documentation. Special attention is given to system set-up, descriptions of every available command, system software maintenance, security measures, and hardware troubleshooting. The manual is supplemented by a bimonthly newsletter that announces new products, updates, patches, user contributions, etc.

Gifford appears to take its role of providing customer support quite seriously and offers several types of support, including the newsletter, an on-line message system, and a dedicated telephone-support staff. I have used the latter service several times; the support offered by the Gifford staff is unparalleled in the industry. The people are knowledgeable and involved in the software-development effort at Gifford.

Since all boards sold by Gifford are CompuPro CSC grade, they carry an unconditional two-year replacement warranty. I recently experienced a failure of an M-Drive/H board, contacted Gifford, and had a replacement board the following day. I am not aware of the service policy on hardware more than two years old or not from CompuPro.

CRITICISMS

This review is complimentary. I should admit that frankly I find little on which to fault Gifford, and I am not inclined to review a product unless I feel strongly enough about it to use it heavily over an extended time period. To be fair, however, there are some areas needing improvement.

The most serious problem I have with MP/M 8-16 is its treatment of modem ports and its lack of autologout. Another problem area is the use of the M-Drive/H as drive A:. Although the basic speed advantage is there, it seems that several utilities, particularly those dealing with user accounts and passwords, do not deal effectively with a volatile A: drive. There are ways to get around this shortcoming, but they are circuitous and are not documented.

Another shortcoming is that the so-

(continued)

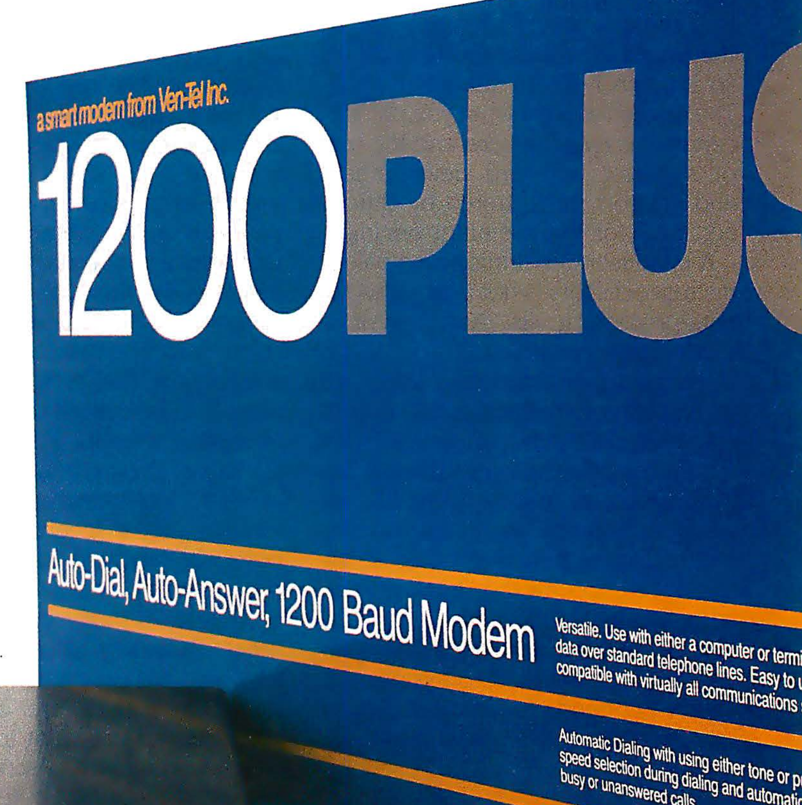
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Compatible with "AT" command set	Yes	Yes
Can be used with CROSSTALK-XVI or Smartcom II software	Yes	Yes
Regulated DC power pack for cool, reliable operation	Yes	**No**
Eight indicator lights to display modem status	Yes	Yes
Speaker to monitor call progress	Yes	Yes
Attractive, compact aluminum case	Yes	Yes
Two built-in phone connectors	Yes	**No**
Compatible with The Source and Dow Jones News Retrieval	Yes	Yes
Unattended remote test capability	Yes	**No**
Phone cable included	Yes	Yes
Availability	Now	
Price	**$499**	**$699**

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phistication of the OS has extracted a dear cost in terms of system RAM requirements. It is safe to say that there is no such thing as too much RAM on an MP/M 8-16 system. The 384K-byte three-user system widely advertised by Gifford indeed supports three users in many cases, but another 128K bytes of memory would make life much more pleasant. This is really more of an observation than a criticism. Gifford freely admits this requirement. In fact, the company encourages prospective purchasers to consider more RAM in their planned systems and warns that the budget-conscious may run into difficulty. Each 8-bit process running under the OS requires a 64K-byte block of contiguous RAM, while it is possible that a 16-bit process could require more or less than this. Making matters worse, Gifford charges virtually list price across the board for the hardware it offers, so bargain hunters need not apply. The axiom "you get what you pay for" certainly is relevant here, and the cost of superior software development and support staff offered by Gifford accounts for the premium pricing.

A multiuser OS running on a pair of microprocessors is not a panacea for data-processing ills. Although it is theoretically possible to run an MP/M 8-16 system with a dozen users, it's probably more realistic to use four to six consoles simultaneously. This depends upon the type of work being performed; running WordStar, for example, is much less taxing on system resources than SuperCalc is. Gifford seems to view the "horsepower" issue in a practical light and will be able to advise a prospective purchaser if an MP/M 8-16 system will satisfy his needs (as long as Gifford can get a clear idea of the proposed application).

Recent Developments

With the latest release of MP/M 8-16 (version 2.1G), Gifford has added a significant enhancement it calls "virtual terminals." Modeled after the virtual-console concept of Concurrent CP/M, virtual terminals provide each user with true multitasking operation. In contrast to plain MP/M-86, where a detached process pauses when any console I/O (input/output) is required, virtual terminals let terminal output be buffered to a temporary file. You switch screens with a user-defined "escape" sequence and thus can conveniently toggle among up to four virtual terminals per physical terminal. Gifford's implementation of this feature depends on hardware in the display terminal to support an additional page of display memory for each virtual screen so that you do not lose your bearings when switched among virtual terminals. In other words, if there is no console output while a given virtual terminal is in the background mode, no screen updating will take place when this terminal is called back into the foreground. This contrasts with Concurrent CP/M, which enables RAM-resident screen buffering for each virtual console and automatic screen redraw whenever a console is brought into the foreground. Gifford apparently decided that the software and space overhead required to support a lot of terminal hardware for implementation of virtual consoles as envisioned by Digital Research for Concurrent CP/M is prohibitive. That argument certainly has merit, and addition of hardware to support the background screen displays has the benefit of no additional processor overhead as required by the Digital Research approach. I have, in fact, implemented the Gifford virtual-terminal scheme on hardware both with and without alternate display memory; I have found the latter is usable, though inconvenient at times. Programs such as WordStar, which do not have a command to repaint the screen, are certainly inconvenient if you want to switch between several virtual screens.

What do you pay in terms of systems resources for the virtual-terminal feature? Memory, more memory, and still more memory. Not only does the MPM.SYS file grow by approximately 64K bytes (its typical size now on the order of 160K bytes), but each additional task initiated by a user naturally requires an independent, unused segment of RAM. For example, if I run an 8-bit WordStar on VT1, it requires a contiguous 64K-byte block (as does any 8-bit process); and if I am assembling a 16-bit program on VT2 using ASM86, it also requires RAM, just as though another user were running it. It should be clear how quickly my 448K bytes of memory becomes insufficient for several users, all of whom want to run several processes concurrently. Suddenly, 1 megabyte of addressable memory space for the 8088 processor does not sound infinite after all.

The addition of virtual-terminal operation to MP/M 8-16 represents the zenith of development of this OS. Gifford's virtual-terminal scheme was inspired by Concurrent CP/M (now apparently called Concurrent DOS) from Digital Research. Gifford is already running its own version of Concurrent CP/M 8-16 in house and will be releasing it by the time you read this. The user interface will be virtually indistinguishable from MP/M 8-16, but Gifford has promised significantly improved hard-disk speed.

Gifford is also quite proud of its implementation of DR Net, a local-area network based on Datapoint's ARCNET hardware and released along with Concurrent CP/M. DR Net supports the networking of CompuPro and IBM PC hardware running under Concurrent DOS. Each user may have access to any peripheral or system resource on the network. Gifford is busily modifying its utilities to operate across the network.

Summary

Although the use of an S-100–based system may seem anachronistic compared to some of the newer desktop and portable computers, the Gifford system offers several important advantages. The CompuPro hardware is rock-solid and reliable. The MP/M 8-16 operating system lets you access a tremendous base of both 8- and 16-bit software. Because it is tailored to a particular user environment and comes complete with all equipment and software, Gifford's MP/M 8-16 is a very attractive system. ■

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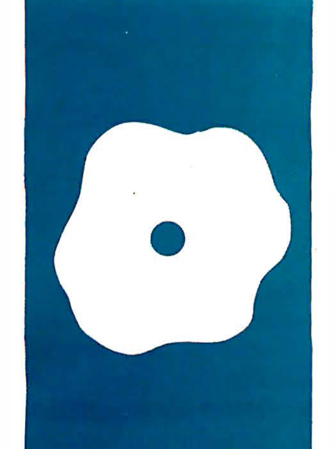
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SOFTWARE REVIEW

Lotus's Symphony

Real and rational advances over 1-2-3

BY DICK POUNTAIN

After Lotus 1-2-3 was released, Lotus Development Corporation was faced with the problem that every hit-maker faces: What next? The company responded with Symphony, another large multipurpose spreadsheet program (see the Preview "Symphony: A Full-Orchestra Version of Lotus 1-2-3," by Rik Jadrnicek, July 1984 BYTE, page 121).

When I first used 1-2-3, I had a feeling that Lotus had raised the stakes in the personal computer software market. It wasn't so much a matter of performance because, although the program works very well, you can find competitors in each of 1-2-3's application areas that perform equally well. It was the design, ergonomics, documentation, and packaging that made 1-2-3 a superior product. Lotus 1-2-3 was a polished product in an industry that had needed a good dose of professionalism.

Symphony is based on the same spreadsheet data metaphor as 1-2-3, and this spreadsheet is also located entirely in main memory. Despite last year's rumors, it doesn't have any form of virtual memory management (i.e., swapping to and from disk to make the memory look bigger).

When you first boot Symphony up, the displayed spreadsheet looks similar to 1-2-3's, and an experienced 1-2-3 user could start entering data immediately. However, significant differences in the command-menu structure soon become apparent. When you use Lotus 1-2-3 you press the slash key to access one master command menu, but Symphony has two menus. You access these with the IBM function keys F9 (called "Services" on the supplied plastic overlay) and F10 ("Menu").

The F10 key brings you to a menu that roughly corresponds to the 1-2-3 master menu (Lotus also lets you access this menu by pressing the slash key). However, the Symphony/1-2-3 menu options don't correspond; some of 1-2-3's options are now in Symphony's Services menu and some submenus are in different places. This means that only a few of the 1-2-3 keyboard macros will run unaltered on Symphony, and many will run with undesired results (e.g., /ws will give you "Worksheet Status" in 1-2-3 and "Width Set" in Symphony).

Symphony menus work even better than 1-2-3's. They're well designed and can easily cope with the extra function load by presenting different context-specific main menus for each environment. The program's services, on the other hand, remain the same as 1-2-3's throughout, including such basics as file saving and retrieval. Overall, Symphony provides a good balance between command consistency and context sensitivity.

Symphony's on-line help facility (the F1 key) is just as good as 1-2-3's so you won't have to spend much time poring over the manuals. However, because Symphony is so large, the help facility can't fit on the same disk as the rest of the program. You have to replace the program boot disk with a Help and Tutorial Disk (in drive A) if you want on-line help on a floppy-disk-based system. I could do without this disk swapping, but Symphony handles it gracefully and gives you all the right prompts at the right times. On an IBM PC XT (or other machines with larger floppy disks) disk swapping won't be a problem.

WINDOWS

Lotus 1-2-3 has a limited form of "windowing"; it splits the spreadsheet into independently scrolling areas. In Symphony, the windowing capacity has been enhanced enormously. You can create different types of windows that can be moved around freely on the screen, shrunk or expanded, and overlapped. Symphony has five types of windows that correspond to the five separate application areas of the program; the spreadsheet window is called Sheet, the word-processor window is Doc, the database-manager window is Form, the graphics window is Graph, and the telecommu-

(continued)

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nications window is called Comm.

It's important to understand how Symphony windows differ from the "desktop" style of windows used by the Lisa, Macintosh, Visi On, etc. Symphony's windows present different ways of viewing the *same* data. The spreadsheet, organized in cells, is always the base program. You can change the type of window at will. For example, you can enter a document into a Doc window (which looks like a word-processor screen with a format line), move it to a Sheet window (the text appears in a column of the spreadsheet), and then transfer it to a Comm window and send it to a remote computer with your auto-dial modem.

On the Lisa, the different windows let you accomplish different tasks, which are performed by different programs on different data files. To exchange data between the different windows (hence, different files) you have to cut and paste.

Symphony also can let you look into different jobs (perhaps a financial model and a report), but those jobs would have to be in different areas of the same spreadsheet in memory. This makes the program less complex than the Lisa's desktop environment, but it is not necessarily inferior.

An IBM PC with a Symphony program runs faster than the Lisa or Mac loaded with a similar application. Because all the data is in RAM (random-access read/write memory) Symphony is never disk-bound and the program's response time is very fast. This is particularly true when you have to copy and move data; the spreadsheet operations are much faster than cutting and pasting.

The main drawback to Symphony's type of windows is that, by sharing the spreadsheet between different jobs, Symphony places some of the onus on you to make sure that the jobs don't interfere with each other. For instance, inserting and deleting columns or rows globally can interfere with something at the other end of the sheet.

Symphony doesn't use a mouse to manipulate windows. Instead it relies on the function and cursor-control keys (in established Lotus style). The commands are exceptionally well thought out and I doubt that using a mouse would be any faster. For example, you can flip between windows by hitting a single key; if you hit the Alt key and the first key again, the current window will "zoom" to full screen size. If you use the End key in conjunction with the other cursor and page keys you will be able to move quickly around even the largest sheets or documents.

Symphony helps you isolate different data areas on the sheet. For example, in the database and word-processing environments it won't accept data that would overwrite occupied cells. In addition, you can restrict the cursor's movement within a window to a specified range by recording its boundaries on a settings sheet.

Every part of Symphony has its own settings sheet. These appear as control panels when you choose "Settings" from the menu. These sheets can be given unique names and saved on disk independently of the main worksheet. Document settings sheets store document formats; Form settings sheets store the structure of databases; Window settings sheets store the name and properties of a window, etc.

Experienced Symphony users will have a complete set of such sheets so that each application will boot up exactly the way they want it. For novices, settings sheets can be somewhat overwhelming; it's probably best to set your screen parameters manually from the keyboard. The settings sheets are good news for the "value-added" vendors. Together with the extended macro language, which I will discuss later, they make it easy to write custom applications in Symphony.

Doc

The text-editing facilities in 1-2-3 are so rudimentary that Lotus, showing commendable restraint, never claimed that it had word-processing capabilities. However, the word-processing facility in Symphony should be adequate for any low-volume user. It does not have features that professional and technical authors may demand (for example, it lacks footnote management and conditional page breaks), and techno-snobs may lament the absence of screen-displayed attributes such as boldface and italic. And it doesn't have a spelling checker. On the other hand, it's simple and pleasant to use, which cannot be said for some of the state-of-the-art programs I've seen.

To enter text, you create a Doc window or change the type of an existing window to Doc. The row and column numbers disappear and are replaced by a format line showing margins and tab stops. Then type as you would with any other word processor. The editor can insert text and overtype. It has automatic word wrap and automatic justification (left, right, or center) that you can disable if you want.

Printing is largely "what you see is what you get" and there is no separate formatting pass. Double and triple spacing aren't shown on the screen (except as flags). Boldface and other type attributes must be set with embedded codes. However, you can put all the IBM alternative characters onto the screen with the Compose key. Automatic page breaks are not visible, but if you press a Where key the program will tell you your page and line location on the printed document. Manually inserted page-break characters are visible.

The Search and Replace functions are excellent; they allow you to manually replace or skip some specific instances of the target test and then say "go ahead and do all the rest"—a feature that is missing from many well-known word-processing packages. The Search function is case-sensitive, and paragraphs are automatically rejustified after text is replaced.

Symphony lets you invoke special lines in the text that override the margin, tab, and indent settings of the master format line at the top of the screen so that you control the page's

appearance. These special format lines can be given names, stored, and recalled when you need them. You can also invoke a GOTO command to bring up a named format line. Because this system is wholly visual, it is easier to understand its workings than abstract environments or "style sheets," but it is complicated by things such as nested numbered subparagraphs. Headers, footers, automatic page numbering, and date stamping are all supported.

Holding all the text in RAM is not a problem for the hardware for which Symphony is intended. I managed to get a 32,000-word document into an IBM PC with 512K bytes of RAM, and it took less than a second to go from beginning to end. Try that with virtual memory!

Symphony has all the facilities of a spreadsheet, database, and programming language available when you are word processing. With Symphony, it's possible to write formulas or macro programs to do mail-merge and other document manipulation.

FORM

The Symphony database is the program's largest single improvement over 1-2-3. In 1-2-3, Lotus uses the columns of the spreadsheet for fields, which make the data structure tangible. Unfortunately, this involves the user at too low a level, defining input and output cell ranges.

In Symphony, this feature has been replaced with the Form window. To set up a database in Symphony, type the names of the fields you want into consecutive spreadsheet cells. Then create a Form window. When you hit the GENERATE command, you'll be asked to choose the default field type and length (from a menu), and then to point to the range of cells containing the field names. The new window becomes a data-entry form. Data can be entered immediately and all your interaction with the database (including searches and sorts) can be performed with this form if you want.

Browsing through the records, inserting and deleting records, and

(continued)

AT A GLANCE

Name
Symphony

Manufacturer
Lotus Development Corporation
161 First St.
Cambridge, MA 02142
(617) 492-7171

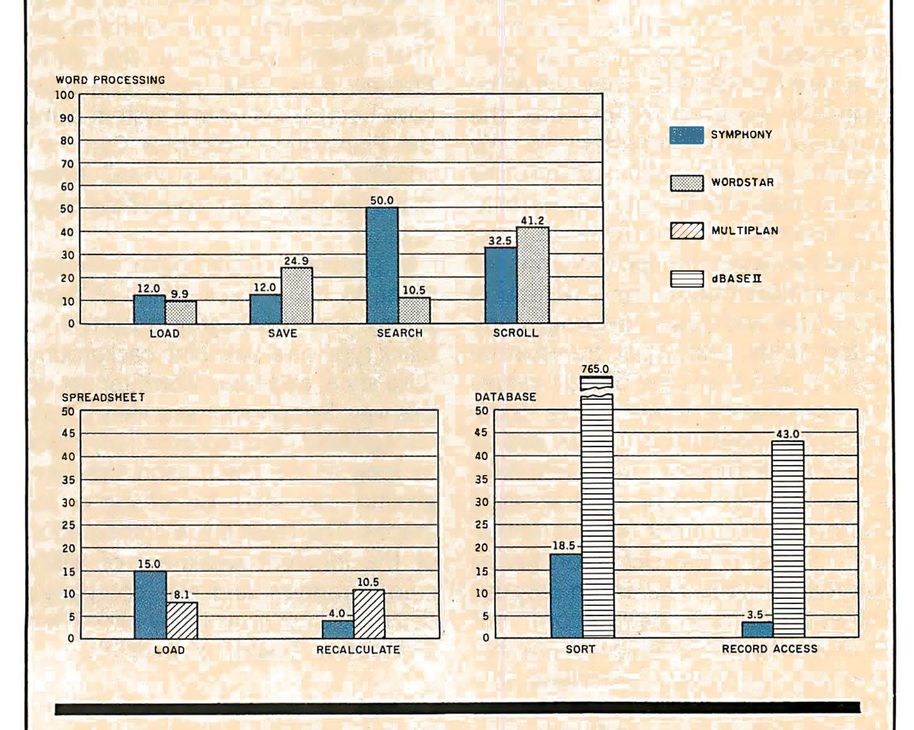
Price
$695

Size
Program takes about 300K bytes of memory and Lotus recommends at least 320K bytes

Features
Variable, overlapping windows; data can be viewed as text, spreadsheet, or structured records; integral report generator; programming macro language; add-on applications; drivers for displays, printers, and modems

Documentation
Two manuals, an *Introduction* booklet, a *Quick Reference Guide*, and a *Glossary*; disk-based Help and Tutorial Disk program

Comments
Easy to use and learn; fast response in most operations; individual functions (spreadsheet excepted) are not as powerful as best of stand-alone competitors; could serve well as sole computing resource if your data volume is low



A comparison of Symphony with stand-alone packages specifically designed for word processing, spreadsheeting, and database management shows that Symphony performs well in all categories. Its very fast times compared to dBASE II in the Record Access test should be read with the knowledge that Symphony's records are indexed, while dBASE II's are not.

editing field contents can all be accomplished by the appropriate IBM control and cursor keys.

To perform a search and select operation, choose "Criteria" from the Form menu and then fill in the fields you want to match. Any of Symphony's @FUNCTIONS can be used in a criterion, as well as the ? and * wild-card characters. When you return from the menu, the database will appear to contain only those records that match the criteria. To get back to the whole database, choose IGNORE CRITERIA. Performing a sort operation on up to three keys is just as easy. Many Form windows can look at a single database, so some users could be given access to restricted subsets of the data (Symphony also provides locking with passwords). Novice users should find these facilities sufficient for all database operations. More experienced users can switch to a Sheet window to view the raw data.

Symphony has even more special ranges than 1-2-3, and it creates them automatically and transparently when you type GENERATE. They can all be manually tweaked to fine-tune the database. Most important is the Definition Range, which performs the task of mapping the entry form onto the records in the database. This range has several empty columns for the formulas that do input validation (both type and range checking), computed fields, and input transformations. It also holds the default values for nonentered fields. Since Symphony has powerful string (as well as numeric) arithmetic, the Definition Range lets you set up sophisticated databases. The most serious limitation I found of the Definition Range was that computed fields can only use values from their own record, not from prior or succeeding records. For example, you can't accumulate running totals. You'd have to use spreadsheet functions (e.g., @SUM) on a column instead.

The fact that all data has to be in RAM is more of a limitation for a database than it is for the word processor. Even so, a 512K-byte machine will hold 1700 records of 100 bytes—which will do for a price list, mailing list, or even stock control for a small business. Symphony's powerful range of statistical functions can be applied to databases, which should prove useful to analysts of all persuasions from the laboratory to Wall Street.

GRAPH

Symphony's graphing function is somewhat better than 1-2-3's. The most obvious difference between the two programs is that Symphony's graphs appear in Graph windows and are automatically scaled to fit. When you resize a window, the graph is redrawn at lightning speed before your eyes.

I was rather disappointed that I could not have color-graph windows on the same screen as text on my system, which includes the IBM Color Graphics Adapter and an IBM color monitor. The best I could manage was either monochrome graphs and text or a color display where I had to toggle between text and graphics mode. That pretty picture in the BYTE Preview (July 1984, page 121) must have been taken from a system using the Plantronics Colorplus Card; according to the Lotus Install notes that's the only way it could have been created.

In general, I found color management to be a weak point of Symphony. I'm thoroughly addicted to black type on a pale blue background (Lisa style) and I use WordStar set up this way. Symphony has a Henry Ford background color scheme (any color as long as it's black), and the foreground can only be changed for graphs. The reason is a combination of the inherent weakness of IBM's color graphics and the company's desire to cater to as many look-alikes and option boards as possible.

COMM

We Brits still live in the Stone Age as far as telecommunications go. I have a 300-bps (bits per second) coupler (and only a handful of bulletin boards to talk to), while auto-dial modems are about as common as domestic nuclear reactors.

With this proviso, the communications facility in Symphony looks fine to me. Creating a Comm window gives you a main menu. The main menu lets you alter all the communication parameters while you are on line, or load a settings sheet in which you've recorded all the parameters (including telephone numbers and log-on procedures) for a particular source. Symphony will dial numbers for you, perhaps from a database of stored numbers or from a macro program. It lets you prefix the number, if necessary, to get an outside line through a switchboard.

Text can be captured on the worksheet and then looked at via Sheet, Doc, or Form windows. Or you can send any of these types of data to a remote site, with highly flexible formatting options (such as data conversion from foreign character sets). If you're busy when a call comes in, you can switch to a Comm window to receive it without disrupting your work. You can have Symphony answer the phone, unattended if necessary. File transmission under the widely used Ward Christensen XMODEM protocol is built in, but no mainframe protocols are supported. These may be available later as applications. I could only use Symphony in a basic terminal-emulation role, calling a few local bulletin boards. It worked fine, capturing neatly formatted text when required.

MACROS AND COMMAND LANGUAGE

Lotus 1-2-3 has a simple form of programmability: it uses "keyboard macros," which are named collections of keystrokes (represented either as single-letter menu choices or names of special keys in braces) that are executed automatically when you invoke their name. In Symphony this facility has been enhanced to the point where it becomes a full programming language.

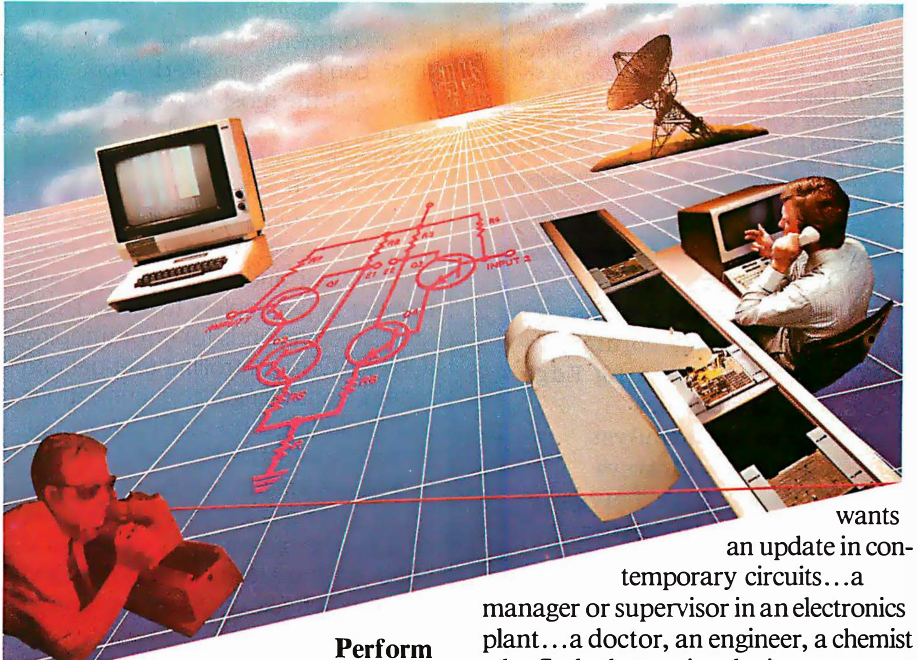
You can still use keyboard macros but now there is an automated way to produce them. Press the Learn function key to set Symphony in Learn

(continued)

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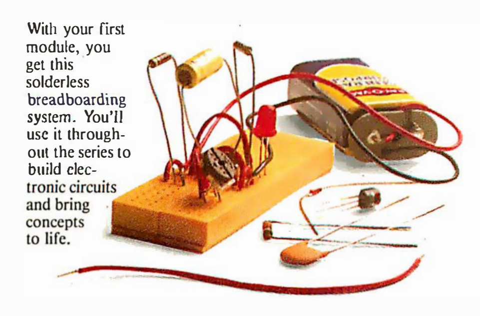


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mode, so that it captures and records all the keys you press. Step through a sequence of operations in Learn mode and the commands will appear in the range you've allocated to the macro.

The command language consists of an assortment of extra commands that can't be invoked from the keyboard; the most important are the control structures (which 1-2-3 lacks). BRANCH permits looping and branching, IF <test> causes conditional branching, and FOR produces a counted loop. Named subroutines are allowed and you can pass any number of parameters to them. There are also commands for error trapping (ONERROR), controlling user-defined menus, controlling a communications link (including auto-dial links), and interaction with the keyboard.

Programming in *Symphonese* takes a bit of getting used to. I like to think of it as the assembly language of a huge and weird chip with 53,000 registers whose contents are visible on the screen.

Because of the evaluation rules of the spreadsheet there are lots of things you can't do (like compute cell addresses for indexed addressing) but you'll usually find a @FUNCTION that will get you out of trouble.

Purely as a demonstration, I managed to get the Sieve of Eratosthenes to run (albeit slowly) and listing 1 shows you that it's readable code. Holding variables in named, single-cell ranges, instead of absolute cell addresses, makes the program read better, but more important, this makes the program relocatable. The @NOW function reads the system clock; Symphony has a comprehensive set of functions for dealing with real-time dates and intervals.

Applications

Symphony can be expanded with command extensions (called Applications) supplied as disk files. These are "attached" or "detached" through the services menu, and they add new options to Symphony's menus. The only Application that comes with the program is one that lets you exit to the disk operating system and run various housekeeping programs before returning to Symphony. It works if you remember to copy COMMAND.COM onto your Help disk.

Performance and Other Matters

I ran the BYTE benchmarks (see the "At a Glance" page) and the results

(continued)

Listing 1: *The Sieve of Eratosthenes in* Symphonese. N*ote that the time shown is for only one iteration.*

```
               {LET start,@NOW}                           1899  count
               {LET count,0}                              8191  i
               {LET A1,1}                                24570  k
fill array     {MENU}CA1 . . A1 ~ A1 . . A8191 ~         16381  prime
1 iteration    {FOR i,0,8190,1,do-sieve}              30910.93  start
               {LET finish,@NOW}                      30910.95  finish

do-sieve       {IF @INDEX (flags,0,i)} {kill-multiples}

kill-multiples {LET prime,i + i + 3}
               {LET k,i + prime}
loop           {IF +k>8190} {LET count,count + 1} {RETURN}
               {PUT flags,0,k,0}
               {LET k,k + prime}
               {BRANCH loop}

                                    Execution time:    38 minutes
                                                       32 seconds
```

compare well with other market-leading packages.

My most serious criticism of Symphony concerns memory management. Symphony requires 320K bytes of RAM to run and showed 218,240 bytes of free workspace on my 512K-byte system. This allows a maximum 255- by 211-cell spreadsheet (53,805 cells), which is large enough for most users. However, like 1-2-3, Symphony uses a fairly naive memory-allocation scheme, so for example, if you add a single number to the extreme bottom right cell (IV8192) of an otherwise empty sheet, it will respond with a "memory full" error.

This is irritating, but there is a more serious problem with garbage collection. When I ran the Sieve program, it created a column of 8190 flags, which uses a lot of free memory. When I erased this column, Symphony didn't take back this space. Storing worksheets on magnetic media when they contain huge amounts of "phantom" data can eat up disk space by filling it full of blanks.

To optimize disk use I had to selectively store the program code (using XTRACT), then reload it and store the whole sheet (with all free space now reclaimed). This means that you have to *think* seriously about memory use if you are using far-flung corners of the sheet, and you will probably have to move some things around.

In a sophisticated program such as this I would have liked to see fully automatic memory optimization and garbage collection using sparse matrix methods.

Documentation

The only complaint you could have about Symphony's documentation is that there's too much of it. As was the case with 1-2-3, the manuals are beautifully produced, fully indexed, clearly written, and comprehensive. There are two huge main manuals (*How-To Manual* and *Reference Manual*), a *Glossary*, a *Quick Reference Guide*, and an *Introduction* booklet that has installation guidance. I found the volume of information overwhelming, and the frequent cross-references between the two main books were disconcerting. The on-line help is so good that previous 1-2-3 users will not have to use the documentation often. And I must say that I feel slightly churlish for complaining about too much documentation in an industry where too little information is a far more common problem than too much. Symphony does a lot of things, hence it needs a lot of documentation.

Conclusions

It would have been easy for Lotus to foul up after a winner like 1-2-3. The company didn't. Symphony provides real and rational advances over 1-2-3 and manages to improve on the already excellent ergonomics of that program. The upgrade from 1-2-3 is a good value for the money *if* you need the extra functions.

I've heard some muttering that Symphony is too complicated. This is not true. The problem is that the program does so much that a user is tempted to try too much too fast. Sensibly approached, every part of Symphony is as easy as 1-2-3. The tutorial program is good; it gets you using all the parts in a simple ways quickly. The beauty of Symphony's design is that all the more advanced features are optional, and you can work up to them as you gain confidence.

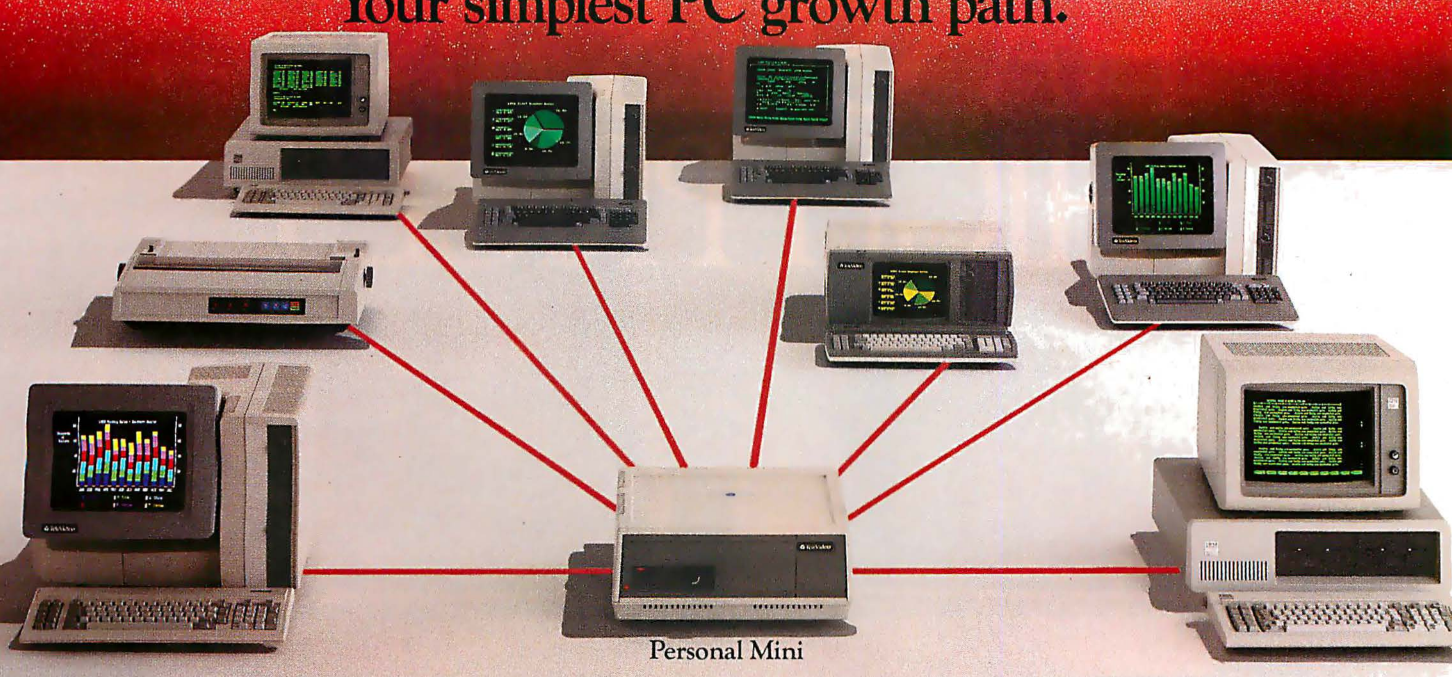
For a certain class of user, particularly business managers and executives, Symphony really might be the only program they need to buy. To get the most out of it though, they'll need about 512K bytes of RAM and, preferably, a hard disk.

The various kinds of data-view can be combined with the new command language in so many ways that it's fruitless to speculate about what you could possibly "do" with Symphony. Merely thinking about the communications facility combined with a real-time clock and macro programs gives me a score of exciting ideas.

I can't shake off the feeling that Symphony deserves a more powerful host than the IBM PC. Many of the criticisms I've made reflect as much on the limitations of that machine as on the program. ■

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  - Jokes about teenage children
  - Travel arrangements?
  - Invitations, coffee and donuts
  - New jokes about spouses
  - Get budget approval
  - Workshop: where to buy apparel wholesale
  - Jokes about new television programs
```

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```
+ 1984 Comedian's Convention
  +Location
    - Wonderama Resort Spa & Carwash
  +Travel Arrangements
    +Arrange air charter through travel agent
      +Lotsa Luck Travel Service, Las Vegas
        - Ida Mistit, agent
  +Agenda
    +Day 1
      +Workshops
        +new jokes about
          - your spouse
          - your neighbor
```

Use as many headings and as much text as you need to develop the outline fully. ThinkTank's processing power can move whole sections of text with a single keystroke—something no word processor can do.

```
+ 1984 Comedian's Convention
  + Location
    - Wonderama Resort Spa & Carwash
  + Travel Arrangements
    - Arrange air charter through travel agent
  + Agenda
    - Day 1
    - Day 2
  + Budget
    - Submit proposal by August 15
  + Publicity
    - Invitations
  + Room Reservations
    - 85 rooms, double occupancy
```

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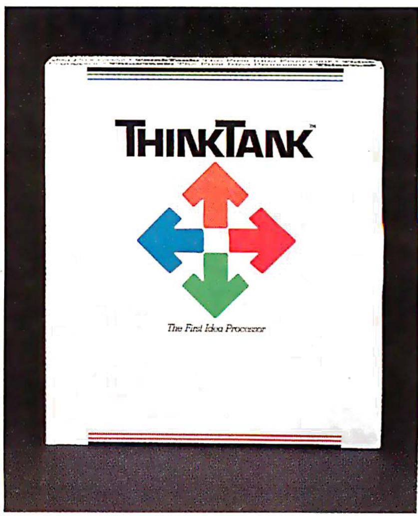
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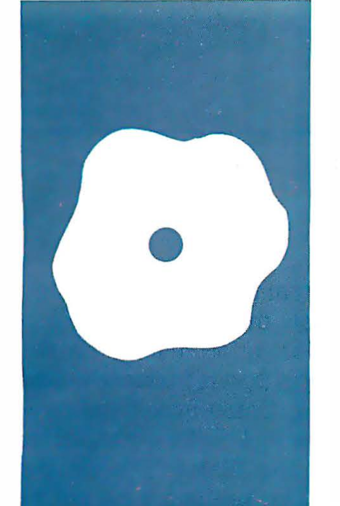
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MagicPrint

A print processor with true proportional spacing

BY ALAN R. MILLER

The difference in print quality between professionally typeset documents and documents produced by most personal computer word processors and standard printers is vast, but three new programs from Computer EdiType Systems are helping to bridge that gap. The first, MagicPrint, which sells for $195, allows you to print documents with true proportional spacing by using microjustification. MagicBind ($250) does all that MagicPrint can do, plus boilerplate insertions and mail-merging. And MagicIndex ($295) has all of MagicBind's capabilities with additional features for creating indexes and tables of contents. Available for any computer running CP/M, CP/M-86, or MS-DOS, these programs can work with WordStar and most other word processors.

Note that none of these programs are word processors. Word processing consists of two separate steps—editing and printing. You create and alter text with an editor program. Then the resulting document is printed out with the word processor or with a separate print-processing program.

You may have to format the text before it is printed. For example, you may want the right margin to be justified or the text to be double-spaced. The document can be formatted either when it is created or when it is printed.

The WordStar word processor formats the document as you compose it. What you see on the video screen is approximately what you get when the document is printed. This feature is especially convenient if you want to see how the result will look or where the pages begin and end. With other word processors, such as PeachText, you use an editor program to create the document and a separate print-processor program to format and print it. With this latter method, the document is composed in a free form, unrelated to the finished appearance. Then the document is re-formed during the printing step. MagicPrint is a print processor that does more than print formatting. But before considering MagicPrint, let's look at several ways that text can be printed.

PRINTING ALTERNATIVES

Typewriters and some computer printers print each letter with a constant spacing or pitch. Ten letters per inch is common, although 12 pitch is also used. With this system, letters from each row line up vertically with those in adjacent rows (see figure 1). Justification of the right margin is obtained by adding extra spaces between words, but the blank spaces are prominent.

Daisy-wheel printers can position characters to the nearest 1/128 of an inch. As a result, the pitch can be set at any desired value. Taking advantage of this capability, WordStar introduced the concept of microjustification, another method for spacing characters during printing. With this technique, right justification is obtained by adding spaces between letters as well as between words. Letters in adjacent lines do not line up vertically. The distance between letters can change from line to line, but for any one line the pitch is constant. This method is sometimes incorrectly called proportional spacing. Microjustification (see figure 2) is an improvement over fixed pitch because the gaps between words are smaller. However, an even better output is possible if each letter is assigned its own size.

If you look carefully at the text on this page, you can see that letters have different widths; some letters, such as M and W, are wide, and others, such as i and j, are narrow. Unfortunately, word-processing programs are generally designed to print at a fixed pitch. Consequently, the characters on standard print wheels have a nearly constant width; that is, the character set has been distorted. The M and W are unnaturally skinny and the letter i is wide. Fortunately, it is possible to obtain print wheels with proportionally spaced characters, where the characters M and W are wide and i and j

(continued)

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are narrow. These wheels have the symbol PS on them to indicate that the letters have proportional spacing. Such a print wheel should not be used for constant-pitch printing because the wide letters will overlap.

MagicPrint is designed to use a PS print wheel to produce true proportional spacing during printing. Each letter is assigned its own width with a print table. Although a document is prepared with a text editor in the usual way, the result is printed out using MagicPrint.

MagicPrint can be programmed for a standard 10-pitch print wheel. However, the results are not a great improvement over microjustification (see figure 3). The problem is that each character of the standard print wheel has about the same width. To fully use the capabilities of MagicPrint, you can program a PS for every letter so that each character is assigned its natural width. The results are now much improved (see figure 4) and are comparable to typeset text.

INSTALLATION

MagicPrint must be configured before it is used for the first time. First, you must choose between one of two separate versions of MagicPrint. One version is compatible with the WordStar embedded commands. The other is for editors such as Electric Pencil, PeachText, Mince, P/Mate, Select, and Word Master.

The installation program alters MagicPrint for your brand of printer and its method of handshaking. Indicating the type of printer is straightforward; just choose the appropriate number from a list given on the screen. Selecting the method of handshaking is more complicated.

A printer can receive data from a computer faster than it can be printed. The printer places the data into its buffer until it can be used. However, if the buffer becomes full, the printer must signal the computer to stop sending data, either by software or by hardware. One method of software handshaking is known as XON/XOFF, completed by sending the common Control-Q Control-S pair. Another method, called ETX/ACK, uses Control-C Control-F.

An alternate approach uses hardware handshaking. When the buffer is full, the printer changes the voltage on a wire running to the computer, which signals the computer to stop sending information. Pin 20 on the RS-232C serial port is frequently used for this signal. Unfortunately, the computer may be looking for the signal on pin 6 (e.g., the IBM PC), while the printer may be sending it on pin 11 or pin 19. Thus, when you run the installation program, specifying the handshaking method is important.

CHARACTER WIDTH TABLE

MagicPrint performs proportional spacing by referencing a built-in table of character widths. Initially, this table is configured for the Diablo Bold PS print wheel. If you have a different print wheel, you may want to alter the character table to match. If you have several different wheels, using a separate version of MagicPrint for each wheel may be best. The character table, located near the beginning of the program, can be changed with a debugger program.

To customize MagicPrint, I printed every character for each of my three print wheels (standard 10 pitch, proportional spacing, and script). Then placing a plastic print-shop typeset-

```
The  first  sentence  is  the  same
for  all  figures.  This  figure  is
an  example  of  text  printed  with  a
fixed  pitch  for  Figure  1.  Each
letter  is  separated  from  the  next
by  the  same  amount  and  is  the
same  from  one  line  to  the  next.
```

Figure 1: *An example of fixed-pitch printing.*

```
The  first  sentence  is  the  same
for  all  figures.  This  figure  is
an  example  of  text  printed  with
microjustification  for  Figure  2.
The  distance  from  letter  to
letter  is  constant  for  each  line
but  varies  from  one  line  to  the
next.
```

Figure 2: *Microjustified printing.*

```
The first sentence is the same
for all figures. This figure is an
example of text printed with pro-
portional spacing for Figure 3.
Each letter has its own width, but
the characters are all about the
same width.
```

Figure 3: *Proportionally spaced printing with fixed-width letters.*

```
The first sentence is the same
for all figures. This figure is an
example of text printed with
proportional spacing for Figure
4. Each letter has its own
width, and the characters have
their natural widths.
```

Figure 4: *Proportional spacing with natural-width letters.*

ting overlay on the printouts, I determined the width for every character. The values for the characters for each print wheel were entered into separate versions of MagicPrint using the system debugger.

If you are using the CP/M version (as I did with the North Star Horizon), load MagicPrint into memory with DDT or SID. Dump memory starting at location 200 hexadecimal. You will see the lowercase letters, the uppercase letters, and then the special characters in the ASCII (American Standard Code for Information Interchange) representation on the right side of the screen. The width of each character is given immediately following the corresponding character. You can change the widths with the S command. You can also change the default-line length and character density at this time; the locations are 113 and 114 hexadecimal. Then return to CP/M and save the new version.

Dot Commands

Formatting commands are given to MagicPrint by one of two methods—dot commands or embedded commands. The dot commands begin with two dots starting at the beginning of a line. Several commands can be combined on a single line, but no regular text can appear on this line. The single-dot commands of WordStar are ignored by MagicPrint, and conversely, the double-dot commands of MagicPrint are ignored by WordStar.

The first line of a document typically contains dot commands for turning on the page-numbering function and for setting the line length and the character density. A heading to be printed at the top of each page can be placed next. This section can have its own formatting commands as distinct from the main part of the text; for instance, justification of the right margin can be turned off and the character density can be changed.

A heading to be centered by MagicPrint is not actually centered in the original text but is begun at the left margin. A dot command in the previous line directs MagicPrint to center the text during printing. The result is a considerable improvement over WordStar, which centers only to the nearest character. By contrast, MagicPrint centers each line precisely.

A flush-right command justifies a partial line with the right margin. This feature can be used to place a date on the right side of a letter. Two-column output is obtained by printing a narrow left column, rolling the platen backward with the B command, and offsetting the margin with the M command. Then the right column is printed. You can also use this method to make columns of data line up. Unfortunately, with proportional printing, each line has its own spacing and so columns will not line up normally. This is an inherent limitation of the proportional-printing method rather than of MagicPrint.

Embedded Commands

Unlike dot commands, which are placed on separate lines, the embedded commands appear directly in the text. For the WordStar version, all the WordStar embedded commands are used. These commands include underline, boldface, doublestrike, backspace, subscript, and superscript. By contrast, the standard version of MagicPrint uses a two-character sequence, the first being a left bracket.

Other WordStar-compatible commands are the non-break space and the soft hyphen. The non-break space is used in the middle of a character string (such as a date) to ensure that it will not be split over two lines. You can place a soft hyphen, a Control-underline sequence, in the middle of a long word. As with WordStar, MagicPrint looks for a soft hyphen to break a long word at the end of a line, but the soft hyphen is ignored if it is not needed.

Embedded commands peculiar to MagicPrint are the pitch change and footnote. Normally the pitch of an entire document is selected on the first line with a dot command. However, the pitch of any single letter or group of letters can be set by an embedded pitch command. A ligature, such as æ,

(continued)

AT A GLANCE

Name
MagicPrint

Manufacturer
Computer EdiType Systems
509 Cathedral Parkway
New York, NY 10025

Versions Available
Standard version for CP/M, CP/M-86, PC-DOS, or MS-DOS
WordStar version

Format
5¼- or 8-inch floppy disk

Minimum Hardware
Daisy-wheel printer
48K bytes of RAM

Documentation
50-page manual

Price

MagicPrint	$195
MagicBind	$250
MagicIndex	$295

Audience
Anyone who uses a daisy-wheel printer

MagicPrint will move the footnote from the text and put it at the bottom of the page.

can be produced by this means.

The embedded command for footnotes is a useful feature that lets you first place a footnote directly in the text at the point of reference as you are creating the document. Then MagicPrint will move the footnote from the text and put it at the bottom of the page. The footnote text can be separately formatted, like the heading, so that you can shorten the line length or tighten the character pitch, for example. One drawback is that the footnotes are not automatically numbered.

File Merging and Indexing

Text such as boilerplate material and resumes may be frequently needed in reports. However, it is not necessary to actually incorporate this material into each report. With the MagicBind program, you need only indicate at the proper point of the main document that an auxiliary file is to be inserted during printing. The MagicBind program can also perform all of the MagicPrint tasks. (Like MagicPrint, both a standard version and a WordStar version are available.) And of course MagicBind prints with proportional spacing.

MagicBind can also print a set of personalized form letters, each addressed to a different person. Furthermore, each letter is individually formatted so that extra spaces do not appear after short names.

MagicIndex, the third program from Computer EdiType Systems, includes all the features of MagicBind. In addition, it can generate an alphabetical index of selected words in a document with their corresponding page numbers. MagicIndex can also create a table of contents.

Single words or groups of words in your text can be selected for indexing by surrounding them with one of several special symbols. These selected index words are regular words in the text and not separate entries that have to be specially typed in.

You can opt for any of several categories of index entry. Generally, the selected words will appear both in the printed text and in the index. However, the selected words need not necessarily be taken from the printed text, and they will only appear in the index. It is also possible to change the case between the printed version and the index version. Special provisions are made for marking "see also" entries. Of course, text marked for indexing appears strange when viewed on the video screen because of the special indexing symbols.

Problems and Counters

MagicPrint can produce a better-looking printout than WordStar. However, what you see on the screen when creating a file with WordStar is not what you get when the file is printed with MagicPrint. Headings are not centered, page breaks are wrong, and text is not justified. Nevertheless, you can give MagicPrint a keyboard command to display your file on the video screen. Page breaks are then correctly shown but the text is not justified.

MagicPrint is initially configured for the Diablo Bold PS print wheel. However, changing the built-in table to match your particular print wheel is relatively easy if you are a systems programmer but can be difficult for others.

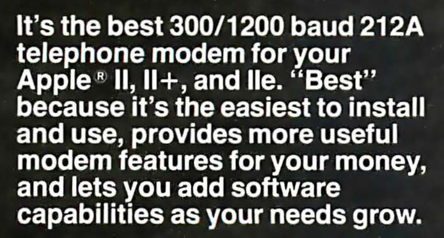
Praiseworthy

MagicPrint is ideal for producing finished documents that require a typeset appearance. As an example, editors of a newsletter could use a word processor and a letter-quality printer to produce camera-ready material. If the look of your printed material is important, then MagicPrint is a superb product. ■

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PROMETHEUS

(1) ProModem 1200A Apple Card Pack, complete with on-board software and all necessary hardware
List Price: $449

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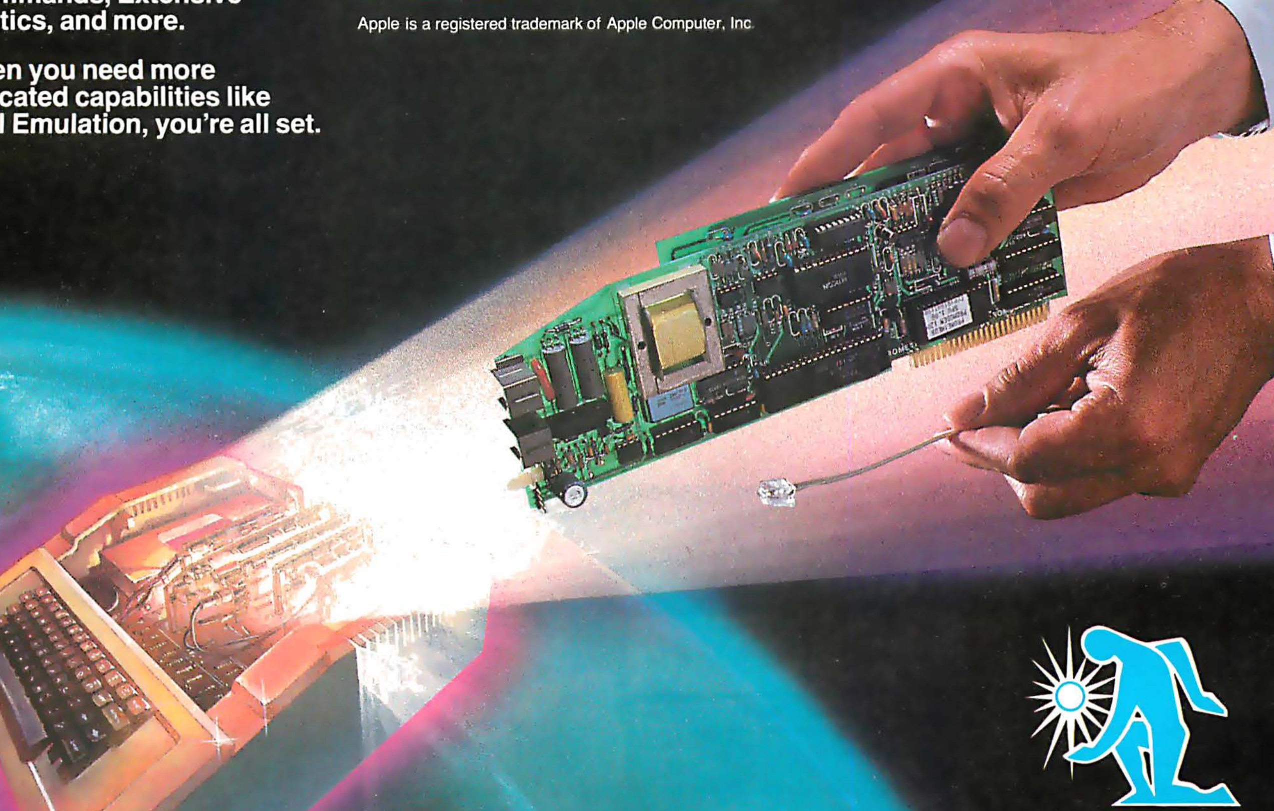
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Keyboard Typewriter-style Detached; cordless	**Expandability** Open architecture Optional 128KB Memory Expansion Attachment(s) 13 ports for add-ons, including built-in serial interface
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The Hewlett-Packard ThinkJet Printer

A compact, portable, and innovative printer

BY MARK HAAS

The ThinkJet printer is a lightweight ink-jet printer that comes in three "flavors": the HP 2225A, with an HPIB (Hewlett-Packard Interface Bus) IEEE-488 interface; the battery-powered HP 2225B, with an HPIL (Hewlett-Packard Interface Loop) interface; and the HP 2225C, with a Centronics-compatible interface for use with most non-Hewlett-Packard computers such as the IBM Personal Computer (PC) and Apple computers. The printers are identical in all other respects including the price of $495. Each printer is about 11 inches wide by 3½ inches high by 8 inches deep and weighs about 6½ pounds. The unit I tested, the HP 2225B, sat nicely on top of the 9114A disk drive I had already connected to the HP 110 portable computer. The ThinkJet features most of the things you'd expect in a printer, including several print pitches, bold and underlining, short line-seeking logic to position the print head, graphics, and reasonable speed. I was also impressed by the ease of setup and use.

SETTING IT UP

Before I could use the ThinkJet printer, I had to connect it to the HPIL, which is Hewlett-Packard's proprietary scheme for connecting computers and peripherals. Connecting any device to the HPIL is child's play because it's virtually impossible to connect the cables incorrectly. In some situations, however, you have to place a device in a certain position in the loop. This is the case when using the ThinkJet in a loop with both the HP 110 portable and the HP 150 desktop computers (using the Portable-Desktop Link): you must position the HP 150 before the ThinkJet printer and after the HP 9114A portable disk drive. The owner's guide that comes with the Portable-Desktop Link provides more details.

Regardless of which interface you have, the next step is to insert the print-head cartridge, which comes in a metal container not unlike those used for salad dressing on the airlines. You remove the thin foil top by peeling it back to reveal the cartridge and a small piece of blotting paper called an absorber. First, you insert the absorber in a small metal clip at the left end of the carriage. The absorber catches the initial spurt of ink the printer makes when first turned on. You then drop the cartridge into the print-head carriage and close the retaining latch by lifting upward. The manual says the latch will snap shut. Mine did not snap, though it was closed firmly. If anything, it seemed to snap when opening the latch.

The cartridge itself is quite amazing. Cylindrical in shape and just over an inch long, the clear plastic cartridge houses a plastic sack containing the ink supply and a solid-state device that squirts the drops of ink. Actually, it's an array of squirters stacked 12 high. Electrical paths lead from each squirter down the front of the cartridge to small contact points. When the cartridge is installed, these contacts connect with matching contacts on the carriage assembly. Changing the cartridge, therefore, not only replenishes the ink supply but also replaces the entire print-head mechanism—for only $7.95. Each cartridge is good for about 500 pages of text and has an expiration date.

Choosing the proper paper is very important. Since the printer is actually projecting droplets of ink onto the paper, the ink will bleed on a paper that is too absorbent—roughly equivalent to writing with a fountain pen on tissue paper. So be sure to buy paper suited for an ink-jet printer. The paper supplied by Hewlett-Packard has only one good side, and therefore you must be careful how you load the paper.

I found the paper loading to be very easy. The left pin wheel (tractor) is fixed so only the right side needs to be adjusted. You insert the paper from the back, under the paper separator, place it behind the pin wheels, and bring it around to the front. There is no platen. After you adjust the right pin wheel and close the paper bail, you're

(continued)

Mark Haas (2600 Tenth St., Berkeley, CA 94710) is the technical director for Osborne/McGraw-Hill.

AT A GLANCE

Name
Hewlett-Packard ThinkJet printer

Manufacturer
Hewlett-Packard Company
1081 Embarcadero Rd.
Palo Alto, CA 94304
800-367-4772

Type
Dot matrix, ink jet

Size
Approximately 11 inches wide by 3½ inches high by 8 inches deep

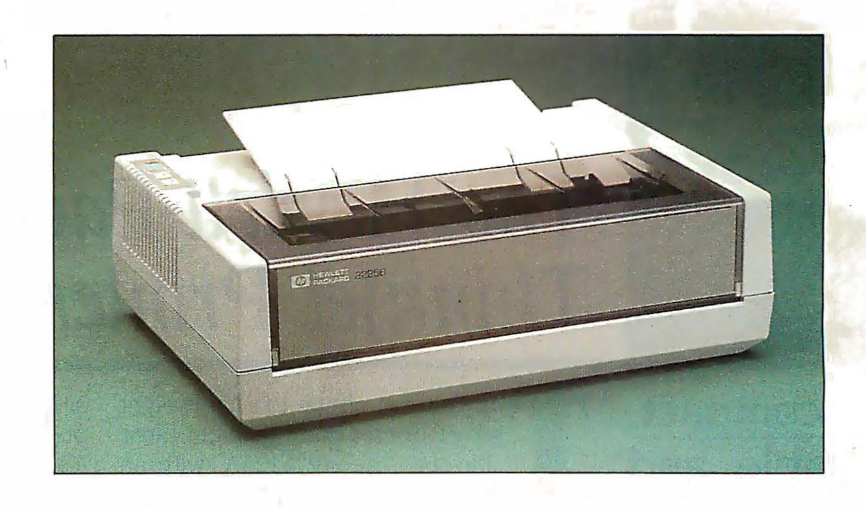
Equipment Needed
Computer with Hewlett-Packard Interface Loop port, Hewlett-Packard Interface Bus (IEEE-488) interface, or Centronics-compatible interface

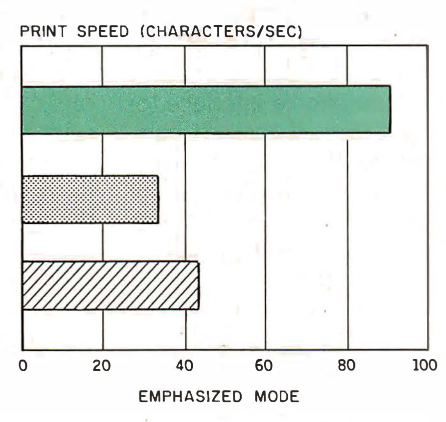
Features
Quiet operation, battery-powered portable (2225B only), 4 pitches, bold, underline, raster graphics

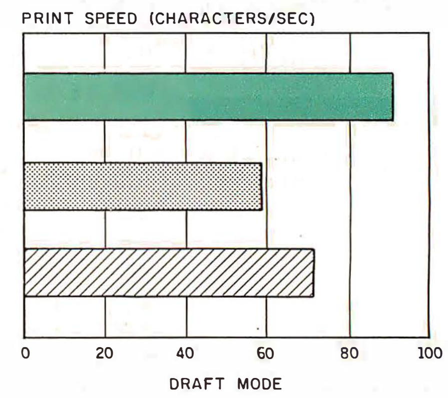
Documentation
78-page owner's manual

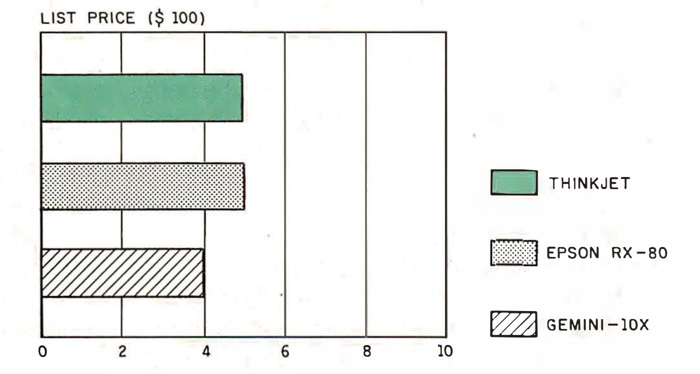
Price
Printer: $495 (all models), replacement cartridge: $7.95

Warranty
90-day limited









This is the Hewlett-Packard 2225B Thinkjet Printer.

This is the Epson RX-80. This is the Epson

This is the Star Gemini-10X This is the St

These graphs compare the ThinkJet 2225B printer with the Epson RX-80 and Gemini-10X in print speed (emphasized and draft modes), list price, and print quality. The print speeds were determined by timing how long each printer took to print 50 lines of 60 As (see "The Art of Benchmarking Printers," by Sergio Mello-Grand in the February 1984 BYTE, page 193). The prices shown are list prices and include tractor-feed mechanisms.

The ThinkJet printer accepts both single sheets and fanfold paper.

done. The ThinkJet will accept both single sheets and fanfold paper.

Since the ThinkJet 2225B is battery powered, you don't have to plug it in before turning it on, which you do by hitting a rocker switch on the back of the printer. You can perform the built-in self-test by holding down the line-feed button and turning the printer on. When you release the button, a programmed set of printed examples will appear, including the full character set, graphics, different pitches, etc. A full page is printed, though you can terminate the test at any time by turning the printer off.

I had never used an ink-jet printer before, and I was impressed at how quiet the ThinkJet was. All I heard was the gentle whir of the motor moving the print head back and forth. There's none of the high-frequency noise usually associated with print-head pins hitting paper.

PRINTER FEATURES

Though the ThinkJet printer doesn't perform as many functions as some of the more powerful (and expensive) printers, it can be quite flexible. Through software commands you can control pitch, print attributes, page length, text length, and graphics.

The ThinkJet can print in four pitches: normal (12 characters per inch [cpi]), expanded (6 cpi), compressed (21.3 cpi), and a combination of expanded and compressed (10.7 cpi). Given the maximum line length the ThinkJet can print, each pitch has its maximum number of characters per line: normal, 80; expanded, 40; compressed, 142; expanded-compressed, 71. The ThinkJet cannot print normal characters at 10 cpi (as called for in BYTE's benchmark tests), so the speed benchmark was performed at 12 cpi.

ThinkJet can print each of the four pitches in bold, underlined, or both, all in one pass of the print head. An example of all the possible combinations is shown in figure 1. You can set the line spacing (either 6 or 8 lines per inch), the page length (up to 255 lines), and the number of lines of text on each page. The last two are related, however, and changing the page length alone automatically adjusts the text length to 1 inch less than the page length. A full line of text still leaves a 1-inch margin on both the left and right sides of the paper, and there is no way to override this. The display functions mode is useful for debugging, and it prints control and escape sequences rather than executing them.

If you intend to use the ThinkJet printer with commercial software packages that have graphics output, such as Lotus 1-2-3, be aware that ThinkJet interprets graphics data that it receives from the computer differently from other popular printers such as Epson's. Unless you are up to writing your own graphics drivers, you

(continued)

```
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!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKL
```

Figure 1: *Print sample from the ThinkJet printer showing normal, compressed, expanded, and expanded-compressed pitches in combination with bold and underlining.*

The ThinkJet is very easy to use, so not much is required for documentation.

should make sure that the software has a driver for the ThinkJet.

DOCUMENTATION

The ThinkJet printer is very easy to use, so not much is required for documentation. The manual includes sections on: initial setup, with appropriate warnings about things like not eating the ink; how to use each printer function and a table containing decimal equivalents of the command sequences that makes BASIC programming a snap; an explanation of the graphics function, including a simple example; a short maintenance and troubleshooting guide; and appendixes on using the printer with the HP 41, HP 71, HP 75, and HP series 80 computers. The manual also discusses how to connect the ThinkJet printer through an HPIL/HPIB (IEEE-488) interface converter.

BYTE BENCHMARKS

As I explained previously, I did the BYTE printer benchmarks for the ThinkJet printer in the 12-cpi (normal) mode. Note that the ThinkJet's print head moves at a constant linear velocity, even for bold and underlining. Since the linear velocity is fixed, the number of characters per second (cps) is really dependent on the pitch of the characters. The ThinkJet prints a line of 40 characters in expanded mode, for example, in the same time as it prints a line of 142 characters in compressed mode, though the latter has a cps rate over 3½ times greater than the expanded mode.

The ThinkJet printer that I tested printed fifty 60-character lines (3000 characters, normal pitch) in 32.96 seconds, or 90.02 characters per second.

Hewlett-Packard is claiming a print speed of 150 cps at 12 cpi, but they are measuring only burst speed and are not including the time it takes for the print head to accelerate and decelerate at the beginning and end of each line, as well as the time to advance the paper one line. To confirm this I printed fifty 50-character lines (2500 characters) at the normal pitch, 12 cpi. This took only 29.7 seconds, which means that the additional 500 characters of the first test took an additional 3.26 seconds (32.96–29.7), for a burst speed of 153.37 cps at normal pitch.

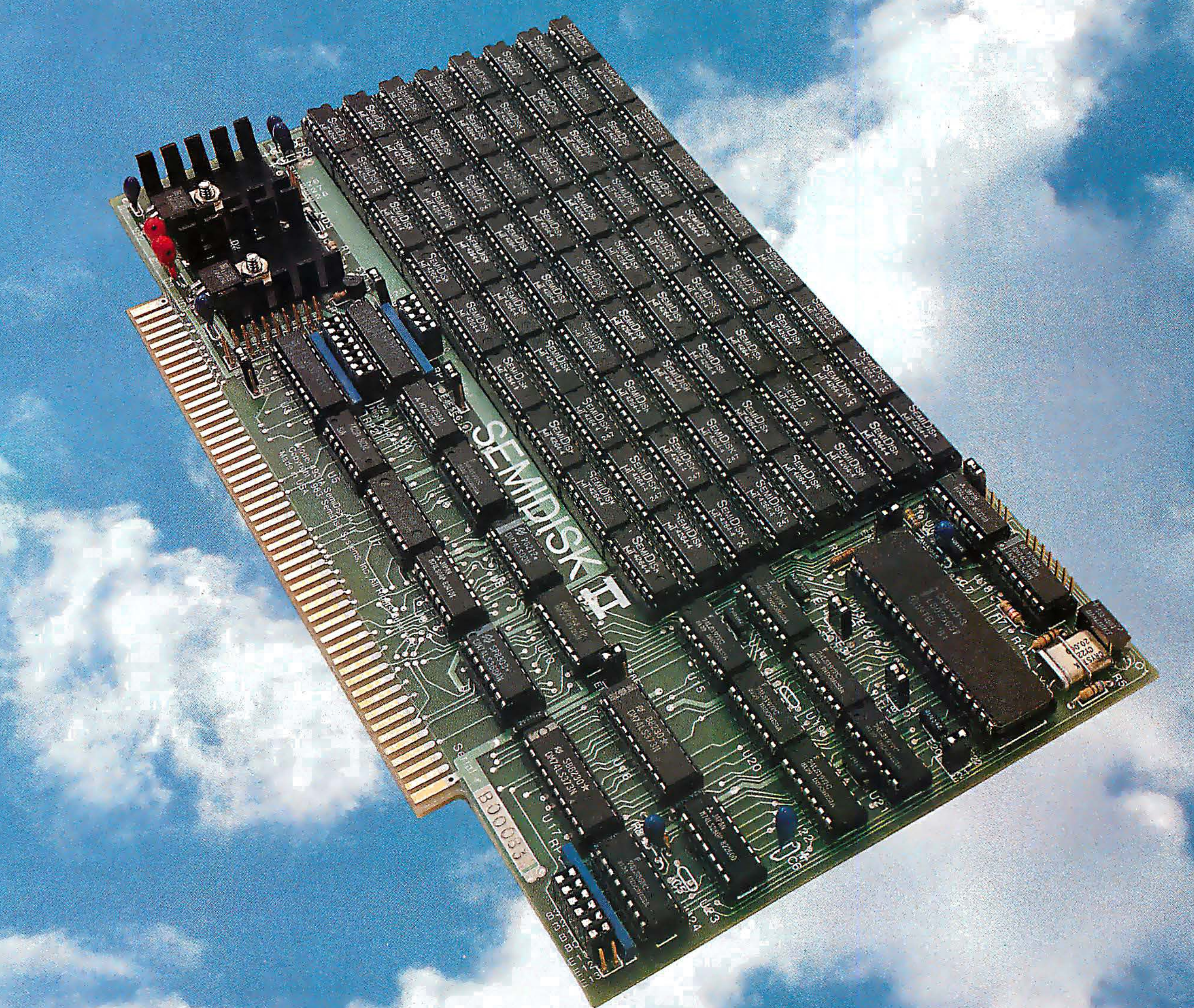
CONCLUSIONS

I used the ThinkJet with a prerelease version of WordStar for the HP 110 portable computer. All functions are supported except for microjustification and variable line height, as would be expected. I printed subscripts and superscripts using the printer's half-line feed function, as no reverse line feeds can be done. But the ThinkJet's ability to print bold and underlining (or both together) in one pass does speed up printing documents containing these attributes. Most dot-matrix impact printers print bold and underlining by overprinting, sometimes several times, and this cuts throughput dramatically in documents containing many of these attributes.

Although Hewlett-Packard provides remedies for unclogging clogged print heads, I had no such trouble while testing the printer, even after it was left sitting unused for two weeks. Changing the cartridges couldn't be easier, and HP even provides you with a new print head.

The 2225B battery-powered ThinkJet printer makes a nice addition to Hewlett-Packard's portable line. The other two ThinkJet models compare favorably to others in their price range. They are quiet, compact, lightweight, and provide enough features to make them useful for most applications. Together with the HP 110 portable computer and the HP 9114A disk drive, the ThinkJet printer completes the loop, so to speak, on a powerful portable computing system. ■

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BYTE Review Comparison Chart

	DATAEASE	Condor	dBASE II
Menu driven	Yes	No	No
Built-in programming language	No	No	Yes
Command/Batch file processing	Yes	Yes	Yes (1)
Custom screen generator	Yes	Yes	Yes
Password protection	Yes	No	No
Prevents duplicate entries	Yes	No	No
Data field masking	Yes	No	Yes (1)
Lookup file capabilities	Yes	No	Yes (1)
Maximum capacities			
Files open concurrently	No limit	1	2
Data-entry forms per file	No limit	1	1
Records per file	65,535	65,534	65,535
Fields per record	255	127	32
Characters per record	8000	1024	1000
Characters per field	255	127	254
Active index keys	255	1	7
Quick report generator	Yes	Yes	Yes
Complex report writer	Yes	Yes	No
Color capabilities	Yes	No	(2)
Uses IBM PC function keys	Yes	No	No
Program file disk space needed	590K (3)	270K	96K
Random-access memory required	192K	128K	128K
List price	$595	$650	$495
Available formats	Most 16-bit	Most	Most
Format tested	PC-DOS	PC-DOS	PC-DOS
Version tested	2.10	2.11	2.40

NOTES: (1) Requires programming. (2) Very limited capabilities, requires programming. (3) Program files may be located on more than one disk.

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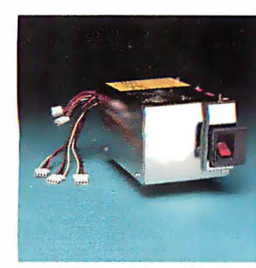
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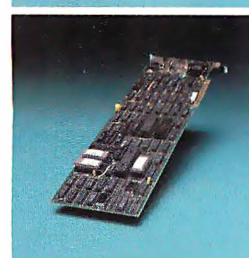
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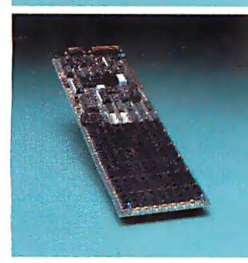
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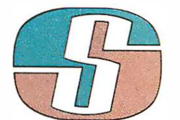
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H·A·R·D·W·A·R·E R·E·V·I·E·W

The TI Omni 800/Model 855 Printer

ROM-based cartridges provide a variety of fonts

BY MARK HAAS

Like most computer users, I often find myself needing printouts of varying quality. Program listings can have a coarse, dot-matrix look, as long as they are produced quickly. The letters I send, however, need a more polished look. The so-called enhanced mode on my dot-matrix printer is better than the normal draft mode but lacks the quality print associated with more expensive dot-matrix and daisy-wheel printers. But most of these cannot produce the graphics I use. Do I need two printers?

The Texas Instruments Omni 800/Model 855 printer is an interesting alternative for those of us in this situation. In addition to providing quick drafts, graphics, and high-quality characters, the 855's unique system of selectable font modules (ROM [read-only memory] cartridges) gives you an easy, flexible way of choosing different type styles. This printer also comes with serial and parallel interfaces that can be connected to most computers. All this, including the tractor-feed mechanism, comes in a compact unit for $995, little more than many dot-matrix printers.

SETTING IT UP

The printer I tested arrived in its factory carton and required me to set it up. This process includes unpacking the printer, installing the ribbon and tractor-drive assembly, setting the tractor width and position, loading the paper and font modules, adjusting the print head, and connecting the cable to the computer.

Unpacking the printer is straightforward, just a matter of checking that everything was in the carton. Installing the ribbon was remarkably easy—I didn't even get ink on my fingers. This involved a trick, however: I used the eraser end of a pencil to roll the ribbon into the ribbon guide in front of the print head. The manual provides another equally valid method and warns of the dangers of a hot print head when changing ribbons after using the printer. The tractor-drive assembly installs easily, too.

Loading the paper was an interesting diversion. In my enthusiasm to get started, I loaded it without looking at the manual. Since the tractors sit behind the platen and feed the paper into it, I passed the paper through them, closed the tractor covers, and turned the platen until the paper passed under it, around and up the front. This worked perfectly.

In preparing this article, however, I decided to follow the instructions in the manual: "Insert the paper [from behind the platen and] turn the paper advance knob to move the paper around the platen . . . until the paper can be laid over the tractor-drive pins. Close the tractor covers." Following these instructions will surely lead you to disaster, because the paper coming out from in front of the platen will be pushed back into the platen by the movement of the tractors. Even the diagram in the manual showing the paper path with dotted lines will cause improper loading. It would lead you to believe that the tractors pull the paper out from the platen, which they don't. Could it be that this diagram and the instructions were "lifted" from another TI printer manual? The bottom line is don't follow the manual to load the paper. It's wrong.

[*Editor's note: Texas Instruments has acknowledged the problem with early editions of the manual and states that it began shipping corrected versions with the printer after March 1.*]

You plug the font modules into the front of the printer in much the same way that a game cartridge plugs into its console. The 855 comes with one font module, Gothic ASCII (American Standard Code for Information Interchange) 96, and room for three font modules. Each module contains a small green LED (light-emitting diode) that lights when that module is selected. You can select modules by software or from the control panel that is atop the printer.

It is possible to configure the cabling from the printer to the computer for either serial

(continued)

Mark Haas (2600 Tenth St., Berkeley, CA 94710) is the technical director for Osborne/McGraw-Hill.

The 855 can operate in two command modes.

or parallel operation. The unit I tested was connected for parallel operation. The pinout is the standard Centronics type, and the manual has complete details on the interfacing. In fact, the cable sent to me from BYTE was not in the correct configuration. I followed the diagram and charts in the manual to reconfigure the cable, and it then worked perfectly.

FEATURES

Turning on the printer causes it to light up like a Christmas tree, as all 12 LEDs on the control panel and each font module light up as part of the self-test feature. After about five seconds, the print head positions itself at the beginning of the line, and the printer assumes the default state. The default state means the printer is in the draft mode (six lines per inch), the lowest-numbered (leftmost) font module is selected, and the printer is in either the word-processing or data-processing mode, as determined by an internal switch setting (more on this below). The font selected determines the character spacing (10 or 12 characters per inch).

Holding the Module Select switch down and then turning on the power causes the printer to produce a barber-pole pattern of characters across the paper. This helps you set the print head and test the different fonts, character and line spacings, and draft and quality modes.

The 855 can operate in one of two command modes: word processing and data processing. In the word-processing mode, the printer accepts most of the commands used with daisy-wheel printers such as the Qume Sprint 9/11 and the Diablo 630. This is useful for printing text with subscripts and superscripts, proportional spacing, and automatic justification. Most word processors have printer drivers for this type of printer. WordStar users in particular can more easily access features since WordStar does not support dot-matrix printers well. Now you can let WordStar think you have a Diablo 630.

The data-processing mode is useful with a program like Lotus 1-2-3, where you want to print both spreadsheets and graphics. The graphics commands for the 855's 60 and 120 dot-per-inch bit-mapped images are identical to those for an Epson FX-80. Lotus 1-2-3 was able to produce single-, double-, and triple-density graphics using its FX-80 printer driver, but the printer did not support the quad-density (240 dot-per-inch) graphics mode. I tested this feature using Lotus 1-2-3 to print the graph of some data. The result is shown in figure 1.

You are able to set the 855 in either the word-processing or data-processing mode by setting a switch near the print head when the unit is first turned on. Subsequently, either mode can be selected by a software command from the computer.

(continued)

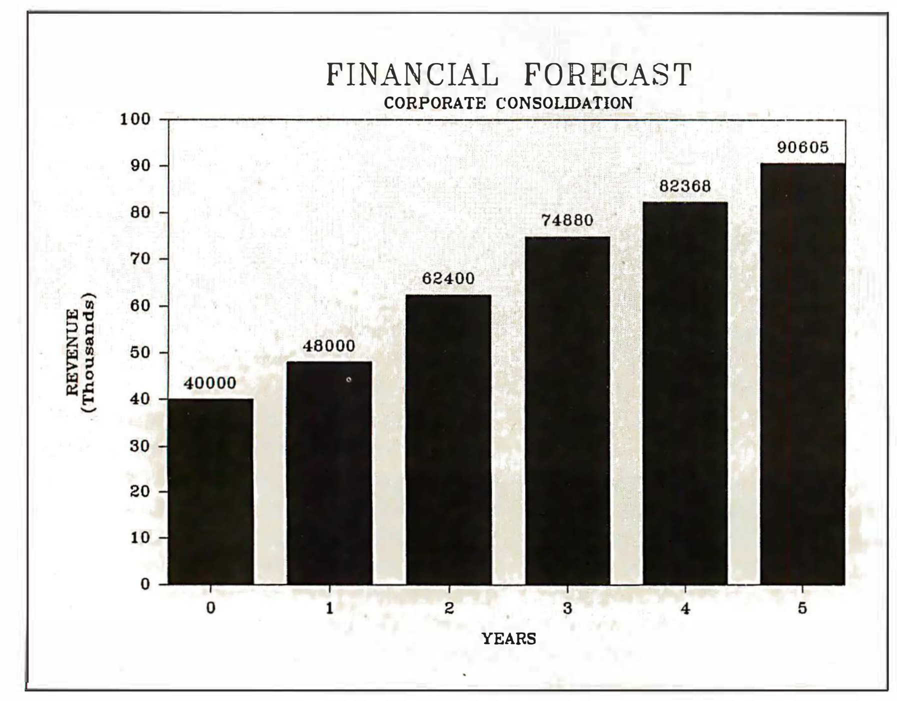


Figure 1: *A triple-density graph produced by Lotus 1-2-3 and printed by the Model 855 printer (from* The Osborne/McGraw-Hill Guide to Using Lotus 1-2-3).

Table 1: *A comparison of the print speed of the Texas Instruments Omni 800/Model 855 printer with tested speeds of other popular printers. For the dot-matrix printers, the test consisted of printing 50 lines containing 80 As. The daisy-wheel printers were tested using Shannon text. All tests were done at 10 cpi.*

	Claimed	Actual
Model 855		
Draft mode	150	115.9
Quality mode	35	29.9
Epson FX-80		
Draft mode	160	95.5
Emphasized mode		60.3
Star Gemini-10X		
Draft mode	120	63.6
Emphasized mode		41.6
Diablo 630	31.8	38.2
Juki 6100	18	18.0

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The 855 performs admirably in regard to print quality.

Within each command mode, you choose either quality mode, a near letter-quality mode with 32- by 18-dot characters, or draft mode, with 9 by 9 dot-matrix characters.

A useful feature is the ability to configure certain parameters from the control panel atop the printer. These include the selection of the font module, character spacing, line spacing, draft or quality mode, setting the top of form, setting the form length, and performing linefeeds and formfeeds without having to go off line. This makes it possible to prepare and print several drafts of a letter, for example, and then print the final copy using the quality mode without having to concern yourself with embedded printer commands or changing printer drivers. A simple push of a button does it. And you can just as easily change the font, too.

```
This is the draft mode.
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890abcde

This is the quality mode.
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890abcde

This is compressed mode.
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890abcdefghijklmnopqrstuvwxyz

1 0  cpi .expanded  print

1 2  cpi . expanded  print  moc

Now let's try the printer jumping jacks e

NUNDNUNDNUNDNUNDNUNDNUNDNUNDNUNDNUNDNUNDN

This is the internal character set at 12 cpi
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890abcdefghijklm

This is the Gothic character set at 10 cp
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890abcde

This is the Gothic character set at 12 cpi, draft
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890abcdefghijklm

This is the Courier character set at 10 c
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890abcde

This is the Courier character set at 12 cpi, draf
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890abcdefghijklm

THIS IS THE ORATOR CHARACTER SET AT 10 CP
ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890ABCDE
```

Figure 2: *Samples of the various print modes and fonts available with the Model 855 printer.*

USING THE PRINTER

I've used the printer for about two weeks and am pleased with it. I put the 855 through several tests, and it performed well on most of them. I tested the print speed in various modes, the forms handling, and overall operation. The "At a Glance" page reports the results.

The burst-speed rating in the draft mode is 150 characters per second (cps), bidirectional, at 10 characters per inch (cpi). When printing purely textual data, the speed is closer to 116 cps (see table 1). This was tested using Sergio Mello-Grand's benchmark test #6 (from "The Art of Benchmarking Printers," February 1984 BYTE, page 193), which involves printing 50 lines of 80 characters.

I performed a similar test using the quality mode. The TI specification for this mode is 35 cps, bidirectional, at 12 cpi. The test results showed the actual print speed closer to 30 cps for both 10 and 12 cpi, a result closer to the published specification. This occurs because, in the quality mode, the print head makes two passes over the same line, printing in the same direction to ensure better registration. Thus, the specification already includes time for head acceleration and deceleration and the time it takes the head to come back to the start of the line for the second pass.

In my mind, the tale of the tape of any printer is its print quality. (Samples appear on the "At a Glance" page.) The 855 performs admirably. As can be seen in figure 2, the quality of the draft-mode print for each character font is excellent. Characters are even, dot formation is very good, and the fonts are legible with true descenders. The quality-mode print approaches daisy-wheel print, although close inspection reveals visi-

(continued)

AT A GLANCE

Name
Texas Instruments Omni 800/ Model 855 Printer

Manufacturer
Texas Instruments Inc.
Data Systems Group
POB 402430
Dallas, TX 75240
(800) 527-3500

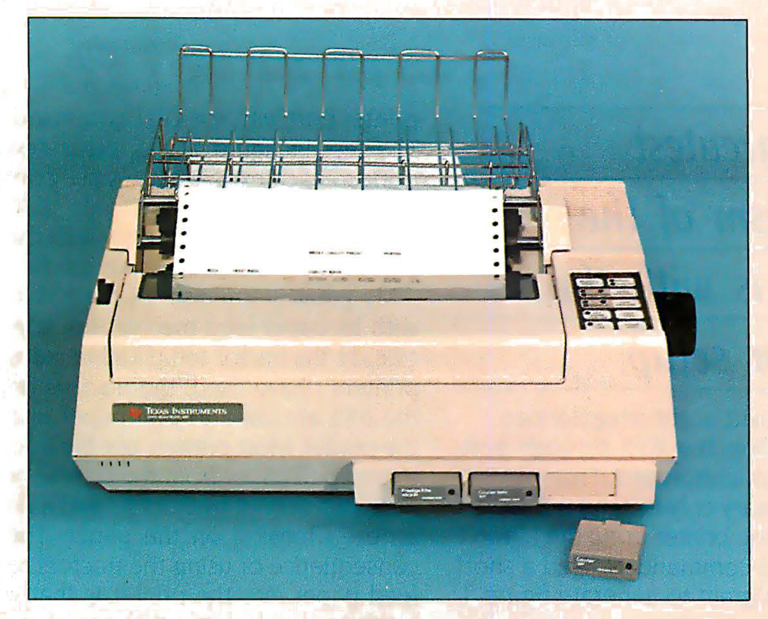
Physical Dimensions
17 by 13 by 5 inches, 15 pounds

Features
Interchangeable font modules; 116 cps in draft mode; 30 cps in quality mode; 7 by 9 or 9 by 9 dots per character in draft mode; 24 by 18 or 32 by 18 dots per character in quality mode; mosaic graphics; Epson-compatible raster graphics in 60 and 120 dot-per-inch densities; also capable of producing 72 and 144 dot-per-inch densities; friction paper feed; parallel and serial interfaces; 256-character buffer

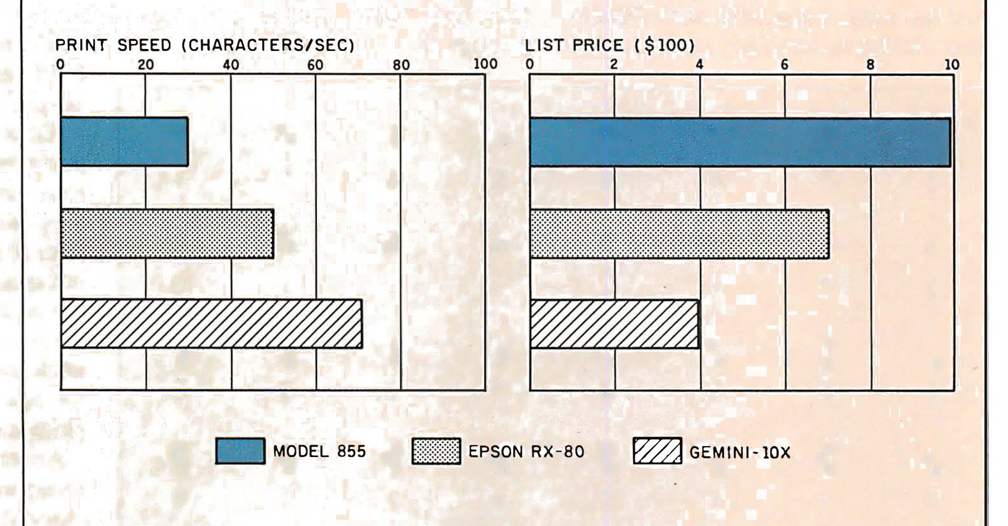
Options
Adjustable-width tractor-drive assembly, paper stacking tray, roll-paper holder, 4K-byte buffer, additional font modules

Documentation
Operator's Manual and *Technical Reference Manual*

Price
$935, friction-feed model
$995, with tractor feed



The Texas Instruments Omni 800/Model 855 printer provides both near letter-quality and draft-quality printing, with a variety of type styles available in removable font modules.



This is the Texas Instruments Omni 800/Mod
This is the Epson RX-80. This is the Epson
This is the Star Gemini-10X This is the St

The Texas Instruments Omni 800/Model 855 printer is compared with the Epson RX-80 and the Gemini-10X (all in draft mode). The pitch for all printers is 10 characters per inch. The print speeds in draft mode were determined by timing how long it took the printers to print 50 lines of 80 As each (see "The Art of Benchmarking Printers" by Sergio Mello-Grand, in the February 1984 BYTE, page 193). The prices shown are list prices, including tractor-feed mechanism.

> *My greatest criticism of the 855 is with the tractor setup.*

ble dots and slight irregularities.

Controlling the 855 through software is straightforward. From BASIC, it is necessary only to send the proper codes to the printer using the LPRINT and CHR$ commands. I used a short BASIC program to generate figure 3, the mosaic graphics characters contained in the 855 (and the ASCII characters to produce them), and to perform the print-speed tests. Using PeachText to control the printer was just as easy, especially with PeachText's ability to send any code out the printer port with the OUT command. The test in figure 2 was generated using PeachText, which was configured to operate a Diablo 630 printer and worked perfectly with the 855 in the word-processing mode.

My greatest criticism of the 855 is with its paper-feed mechanism, specifically, the tractor setup. Unlike many printers I have used, the tractors on the 855 are used to *push* paper into the printer. Most printers use the tractors to pull paper from the printer or have two sets of tractors to maintain an even tension on the paper. The consequence of using the tractors to feed paper into the printer is that it tends to jam. I found that any slight impedance to the paper exiting the 855 during a formfeed will cause the paper being fed into the printer by the tractors to pile up behind the platen. The only thing pulling the paper through the printer is the pressure of the paper-guide rollers on the platen; the friction rollers are disengaged by the installation of the tractors.

Besides the problem with paper jamming, I found this system susceptible to paper skewing. This became evident when performing the printer "jumping jacks" shown in figure 2. The printer is required to alternately perform two half-linefeeds followed by two reverse half-linefeeds. Ideally, all the Us, Ns, and Ds should align horizontally, and in most cases they do. But should the paper exiting the printer encounter any impedance, the characters tend to skew, or droop, in their horizontal alignment. This is also a problem when graphing. In extreme cases, it can cause one pass of the two-pass quality-mode print to be offset significantly from the other. TI even recommends not performing more than one reverse linefeed. I found no problem when using friction feed, as the friction rollers keep a secure grip on the paper.

[*Editor's note: One advantage of having the tractor mechanism on the input side of the roller—and, in fact, the reason for putting it there, according to TI—is that it minimizes waste of paper and forms. Paper tear-off occurs about an inch away from the last printed line on a page, as opposed to printers with the tractor on the output side of the roller, which sometimes require throwing away an entire page or form upon removal of the completed document.*]

Another small annoyance I encountered was due to the lack of any indicator showing what command mode you are in: word processing or data processing. More than once I tried to use the printer with PeachText, set up for a Diablo 630, after using the printer in the data-processing mode with Lotus 1-2-3. After a few pages of printout, strange things would start happening since PeachText expected the printer to be in the word-processing mode, acting like a Diablo 630. I hadn't remembered to reset the switch near the print head to change modes, and there was no external indicator to warn me. Since you can control so many things from the 855's control panel, why not include changing command modes, too?

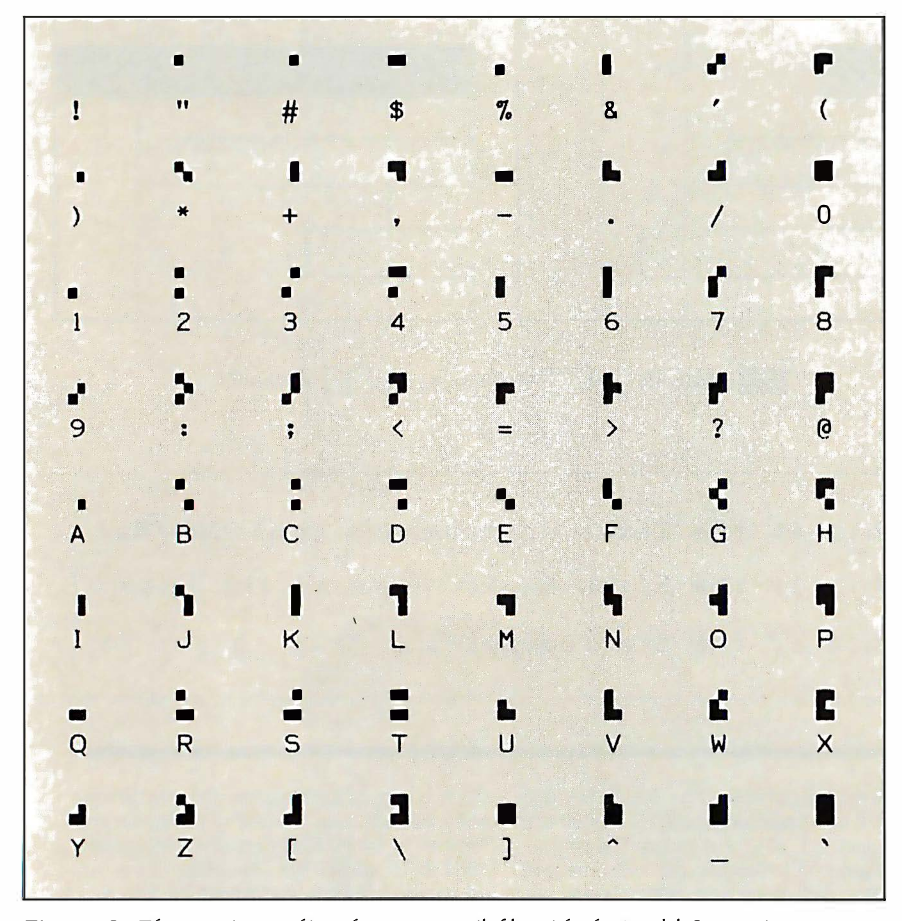


Figure 3: *The mosaic graphics characters available with the Model 855 printer.*

Printer operation was not particularly noisy for an office environment, but those using the unit at home may find the whine of the print-head pins a bit much, especially in the graphics mode when all pins are firing. The clamor from this kind of graphing penetrated a closed bedroom door, traveled the length of my house, and was clearly perceptible over the World War II battle on the television. It should be noted, however, that this was no noisier than other dot-matrix impact printers I have used. TI claims the printer has a noise level of 62 decibels with the tractor.

CONCLUSIONS

Until the introduction of the TI 855 printer, one usually had to choose between buying a printer that produced fast drafts and graphics or one that produced high-quality print. If both were needed, it meant buying two printers or a very expensive one. TI now offers an alternative.

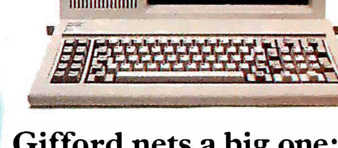
The TI 855 printer provides

- high-speed, draft-quality printing
- moderate-speed, near letter-quality printing
- compatibility with Epson FX-80 graphics commands
- compatibility with daisy-wheel printers
- selectable, interchangeable font modules
- convenient control-panel operation
- mosaic and raster graphics
- parallel and serial interfaces
- 256-character buffer, expandable to 4K bytes

In the near future, TI intends to offer additional options, including downloadable character fonts and a character editor to produce them, the ability to produce double-height characters, a character set fully compatible with the TI Professional Computer's, and more. All this is possible due to the plug-in font modules the printer accepts.

If you want a printer to dance all day with WordStar and still be able to graph your 1-2-3 data, take a look at the TI 855. ■

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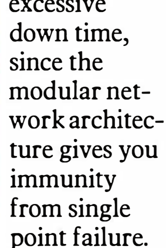
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MULTIMATE 3.20

The article "Word Processing Revisited" by Janet Cameron in BYTE's *Guide to the* IBM *Personal Computers* (page 165) seriously misrepresents the MultiMate 3.20 Word Processor. We think the reviewer paid our product much too short a "revisit," but that does not excuse or explain the many errors.

The review was obviously done in haste by a writer who was much more familiar with other products mentioned. In addition, this special edition seems to have been more interested in "colorful" writing than clarity or accuracy. That's not what readers expect from BYTE.

First I must correct Multimate's phone number. It is (203) 522-2116.

The article is billed as a "new product" review but is actually a review of a product we replaced in March 1984 with MultiMate version 3.22. (See "Leading Edge and MultiMate" by C J Puotinen, November 1984, page 287.) The overlap of BYTE's publication schedule and our publication schedule was truly unfortunate, but the writer made little attempt to find out if the next version changed the things she criticized. The next release of MultiMate for the IBM will be version 3.3, with proportional-spacing capability, ability to merge data from ASCII files at print time, and other enhancements.

Even the article's simplest descriptions of our package are inaccurate. For instance, the reviewer claimed that an alphabetical list of features was lacking. It is in the manual, on the template, and available from our on-screen help facility. Editing *is* discussed at length before merge printing. There *is* a clear reminder to adjust your contrast controls so you can see on-screen highlighting. We don't know why the review said these things are missing from the manual.

Futhermore, the article is contradictory. The "At a Glance" box contradicts parts of the article on reference materials; the spelling corrector is described favorably at the beginning of the article and unfavorably elsewhere. It is a spelling corrector, not just a spell-check program, and it uses an 80,000-word Merriam-Webster dictionary and an algorithm that recognizes phonetic errors. A British version of the speller is also available.

BYTE's benchmark tests usually are important. This benchmark comparison is not explained at all and could lead readers to the false conclusion that it takes a terribly long time for MultiMate to get around inside a document.

A benchmark test of scrolling through a document with the down arrow is misleading in a review of a Wang-like, page-oriented program. Why not have a test of going to a specific page number? Most programs can't do it, while our GoTo key (F1) lets you jump to page 25 as quickly as to page 2. You rarely scroll between pages, since MultiMate takes time to open and close each page on disk when you scroll past a page break. When you save a document, there is only one page left to save. That's why MultiMate was the *fastest* program for saving a file, which the review barely mentioned.

Next, a few words about features and updates. Version 3.20 was a transitional edition of MultiMate. IBM MultiMate version 3.20 users were given *free* upgrades to the next version—at great cost to this company. The free update mentioned in the article was for that version only, but our update policies are still generous.

Finally, we should mention that the review concerned MultiMate for the IBM PC, while there are different versions of MultiMate for the Corona, Texas Instruments Professional, Tandy Model 2000, Toshiba, and other machines. Some features and policies vary under our OEM (original equipment manufacturer) contracts for these versions.

BOB STEPNO
Multimate International
East Hartford, CT

All the software programs I review for various computer magazines receive the same unbiased treatment. I have no vested interest in any word-processing program and am still seeking the perfect word processor; therefore I have no reason to rate one above or below the others. The experiences I have when I exclusively use a program over a period of several weeks are the results I pass along to the reader. And the results I get are exactly the results I report.

Additionally, I use input from all the 100 or more members of the special-interest word-processing user group of which I am a director. And of all the people with whom I spoke about MultiMate, only one had a kind word to say about the program.

A few points: the review was prepared after a three-month review of the five programs. I studied and used the MultiMate program exclusively for a period of several weeks. When reviewing any software program, I assume the position of an authorized user. This is the best way I know of to discover what other "authorized users" will experience when they call 800 numbers for technical support. I asked the Multimate technical-support person and directly quoted her answer regarding whether the next version would correct the errors noted.

Finally, regarding the table on features and performance on page 181: I asked Multimate's personnel each question, verbatim, from BYTE's desired matrix, recorded their responses on tape, and quoted them verbatim.

JANET CAMERON
Cambridge, MA

I was delighted by Janet Cameron's criticism of MultiMate. I recently wrote several chapters of a book using this monster. I could never understand why it led such a charmed life in the magazines. Anybody who had ever repaginated a lengthy document after using the world's most cumbersome spelling checker would share my bewilderment as they watched their text crumble into garbage before their eyes. Sure I had a backup, but I never dared repaginate again. You have probably experienced the scattered format-line effect. I once found 42 format lines in 16 pages of text. The people from Multimate thought it had something to do with the automatic page break, which they suggested I disable.

I have finally settled on a program that suits me better than any of the alternatives. I call this "choice by elimination" and it would not have been necessary if the magazines had been more forthcom-

(continued)

ing about these products. The worst thing about my editor is its name; it's called The Idea Processor. [*To be reviewed in an upcoming issue*].

I hope you will continue to write about word processing. Janet Cameron's frankness may persuade others to speak more critically about these products that so many of us are becoming so dependent upon.

R. C. PACKER
Santa Barbara, CA

LILITH PERSONAL COMPUTER

I read with interest the review of the Lilith machine ("The Lilith Personal Computer" by Paul A. Sand, September 1984, page 300). I can agree with most of the author's statements. However, I've got to contradict one of his opinions about the Lara editor. The author states that, to define the font of a piece of text, one has to type its name (Times Roman) each time. This is not true. Quite the reverse is true. We have made every effort to avoid the need (although not the possibility) of *indirect* specification of looks in Lara, be it via keyboard or via a collection of menu entries (as in the Mac).

It is a basic principle of Lara that any looks and even combinations of looks can be copied simply by pointing with the mouse to any location on the display (within the same document or another) where the desired looks are available. This method applies to characters (font, size, offset, underlining, etc.) as well as to paragraphs (formatting mode, margins, etc.).

As a straightforward application of this concept, we mention the use of a *sample document* from where the looks can be copied into the currently edited text. A sample document typically contains a collection of sample characters in different styles, sample titles, and sample, carefully formatted paragraphs. Once having introduced a look in the current text, it can clearly be taken from there.

J. GUTKNECHT
Institut für Informatik
ETH—Zentrum, Zürich,
Switzerland

SAGE II

In reviewing the Sage II computer in "The Sage II and Sage IV Computers" by Allen Munro (July 1984, page 235), the author says that personal computer users who are satisfied with a 64K Z80 system are "letting their current systems set the limits of their imaginations."

Using a powerful 8-MHz 68000 microprocessor and the UCSD p-System, Mr. Munro's Sage runs the Sieve of Eratosthenes benchmark program, compiled from Pascal, in 74.8 seconds. Wow!

I am the owner of one of those pokey 64K Z80 systems. My Z80 runs at a snail-like 2.5 MHz. Using my $49.95 Pascal compiler it takes my system just about half the time (35 seconds) to run the same program.

JOHN D. FOX
Nyack, NY

SANYO MBC-550

I have just finished reading "The Sanyo MBC-550" by Bill Sudbrink (August 1984, page 270) and was delighted to see that this machine is finally being recognized for its great value and performance. We wrote the *Sanyo 550 Series Personal Computer Handbook* which was published in February 1984 and addresses all the documentation issues found to be deficient by these authors. We followed this up with the first newsletter on Sanyos called "The Sanyo Source" to provide follow-up information that fills in the void from Sanyo.

We feel that our services are a valuable addition to the computer.

FRED ZUROFSKY
Computer User Services
230 Anderson St.
Hackensack, NJ 07601

I found the review of the Sanyo MBC-550 in the August 1984 issue both interesting and informative, but I would like to make a few comments.

Sanyo BASIC can access up to four disk drives. For example, to save a program to drive B the correct syntax is, SAVE"B:filename". Note that there must not be a space between the colon and filename. The syntax for LOAD is the same.

To invoke the FILES command in order to view a directory on a disk on a drive other than drive A, the correct syntax is FILES"B:. Closing quotes are not necessary.

The use of CalcStar to compare spreadsheet handling is grossly unfair. On any machine CalcStar runs slower than Multiplan and has not been optimized to take advantage of 16-bit processors.

At least two companies in the U.S.A. are selling versions of MS-DOS for the Sanyo that can format, read, and write single/double-sided, 40/80-track drives. I am currently running two double-sided double-

(continued)

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Battery Backed Clock/Calendar	Standard	Not available from IBM
Ports	Both Parallel and Serial Standard	Serial—$100.
Expansion Slots	7 slots Standard of which 4 remain open after expansion to 640K	5 slots Standard of which none remain open after expansion to 640K
Warranty	One Full Year parts and labor	90 Days parts and labor
Support	Lifetime no charge toll-free hotline Standard. The best in the industry	None on hardware. Software optional at $40 per call.
Service	Nationwide Service Centers	Nationwide Service Centers
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density, 80-track drives giving 730K and 112 files under DS DOS-80 from Michtron of Pontiac, Michigan.

TOM DRAKE
Ickenham, Middlesex
England

I recently purchased a Sanyo MBC-1000 using the CP/M 2.0 operating system. I am addressing this letter to you because I need your help. I haven't been able to get any answers to my questions from Sanyo in New Jersey, and Fresno doesn't have any service or sales office for Sanyo computer products.

Today's question was brought on by the inability of the SBASIC interpreter to handle a variable filename. I must resort to using an assembly-language subroutine to perform that function. What I need to solve the dilemma is the address and a description of how the interpreter operates on the BASIC statement: OPEN #1,"0", "FILENAME". I wanted to use FL$ in place of "FILENAME". However, I found that to be impossible on this interpreter. FI$ doesn't work either. I know that it can be done in assembly. But to write my routine, I need something that describes that process. I am not an inexperienced programmer. If I could just be led in the right direction, I can accomplish my goal.

ROBERT S. HUNTER
Fresno, CA

INFOSCOPE

On the basis of George Bond's very good review of Infoscope, the database manager marketed by Microstuf Inc. (June 1984, page 367), I decided to purchase a copy. This program has lots of features that make it fun to play with, but for my purposes it is essentially useless. Why? Because it does not accept real numbers in any form other than as character strings, dollar equivalents, or stock prices. For example, 10.381 cannot be entered as anything but a character string. This means that you cannot obtain sums, averages, or true numeric sorts on this type of data. If 10.381 and 3.506 are sorted as left-justified character strings (which is the only way they can be entered into Infoscope), you get the wrong order. You also cannot safely use "greater than," etc., in selecting records. It is necessary to pad the smaller numbers with preceding zeros (e.g., 03.506) to get everything to work out properly. If you decide to limit yourself to two decimal places in order to get a true numeric field, you are forced to live with the dollar sign, even on printouts.

If you are trying to convert data from dBASE II, Infoscope appears to assume that anything with other than two decimal places is character data and that anything with exactly two decimals is "money" data. What a pain.

All in all, this seems to me to be a rather severe problem with Infoscope. I certainly wouldn't have purchased the product if I had known. Perhaps your other readers would appreciate knowing this.

BRUCE LAZERTE
Baysville, Ontario
Canada

MORROW MD-11

I read with interest the letter from Jim Icenhower (Review Feedback, September 1984, page 356) concerning his experiences with the Morrow MD-11.

After a long search for a computer system that would be both dependable and inexpensive, I purchased a Morrow MD-11 for a pharmaceutical application in one of my drugstores. For about seven months we have been using it about 10 hours a day. It is used for most every function connected with running a retail pharmacy and we have had only one very minor problem that was power-supply related. Shortly after this problem, we installed an uninterruptible power supply for power and more line filtration. As of this date we have not had any additional trouble with this MD-11. I know of three others that are working in other pharmacies in this area and have not heard of any additional trouble. Each uses a very fine program that was written by a local pharmacist who now specializes in computer programs for pharmacies.

The reason I bought the MD-11 system was the price and the software that was included. I invested a total of $7000 in both hardware and software (including the pharmacy program). The starting price of similar systems would be about $14,000.

I feel the MD-11 is a great value—and when I need to computerize my other store it will probably be with a Morrow MD-11.

R. A. MITCHELL
Sumas, WA

REVIEW FEEDBACK is a new column of readers' letters. We welcome responses that support or challenge BYTE reviews. Send letters to Review Feedback, BYTE Publications, POB 372, Hancock, NH 03449. Name and address must be on all letters.



RUN-TIME VERSION AVAILABLE

THERE'S NO

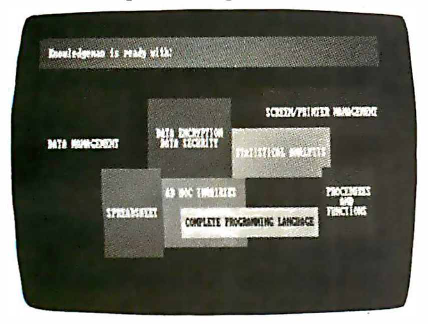
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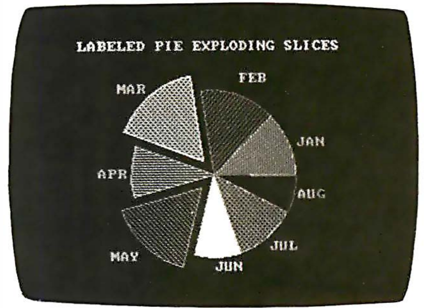
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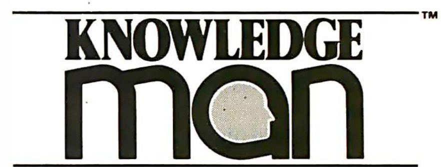
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Inquiry 227

Kernel



THINGS MOVE PRETTY FAST at Chaos Manor, and this month Jerry Pournelle discusses time's consequences: a growing list of obligations and new product arrivals must fit into the same 24-hour day.

In London, BYTE U.K. columnist Dick Pountain looks at the Amstrad CPC 464, a "home" computer that shows promise for business purposes, too.

From Tokyo, Bill Raike reports on increasing chip densities, some new products, and software skullduggery alive and well in Taiwan.

The BYTE West Coast gang visits the Mac at college and also takes a look at mice and laser disks.

Also this month, Steve Ciarcia answers readers' letters about his Circuit Cellar projects in Circuit Cellar Feedback, and Michael Ecker discusses "counting without enumerating" in Mathematical Recreations.

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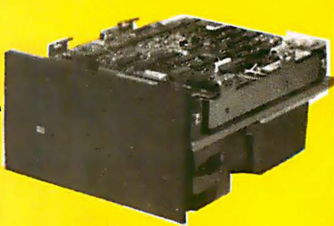
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30MB External	BMIIIHOPCX30	$189500
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IBM 13" color RGB 28lbs.	BMIBM5153001	$ 68000
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These prices are so low, the manufacturer has requested to not be identified

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SDS SBC-300 6MHz	BMSDS38092	$ 69900
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SDS VersaFloppy III	[illegible]	[illegible]
with 5¼" unbanked CP/M 3.0™	[illegible]	[illegible]
with 8" unbanked CP/M 3.0™	[illegible]	[illegible]
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with 8" banked CP/M 3.0™	[illegible]	[illegible]

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JMR Dual half height vert. mount 7lbs	BMJMR2SV5	$ 65 00
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COMPUTING AT CHAOS MANOR

The Fast Lane

BY JERRY POURNELLE

If it isn't one thing, it's another: no sooner did Larry and I get *Footfall* completely done—copied, edited, table of contents, quotes verified, copied again, and off to Judy-Lynne Del Rey—than the phone rang. It was ye editor Phil Lemmons with a request. They're speeding up BYTE's cycle time, getting the magazine out earlier. But in order to do that, I'll have only three weeks each for the next three columns.

The result will be more than worth it, with nearly a month cut off the lag time from when I turn in a column until you see it, but it does mean more scrambling here at Chaos Manor. Oh, well.

ORCHIDS TO YOU

Now that IBM has come out with the AT (advanced technology) machine, a number of IBM PC owners are worried: what will happen to their machines? Can they be upgraded?

I have two bits of good news. First, Dian Girard is doing a book (in the Pournelle Users Guide series) on upgrading your IBM PC; it ought to be out next summer. Second, we have Orchid's PCturbo 186.

Orchid Technology's PCturbo 186 board turns out to be the nicest thing that's happened to our IBM PC in months. We have version 1.1; I'm assured by Orchid's Ron Wiener that version 1.2, and possibly a later one than that, will be available by the time you read this. The new versions will be compatible with even more hardware and allow communications at higher rates. (I also expect Orchid will have redone the documentation by then; on that, *much* more below.)

The PCturbo 186 is a board containing an Intel 80186 chip; ours runs at 8 MHz. After you install the PCturbo board the 186 takes over, with the result that the IBM PC runs about three times as fast. The difference isn't just in computing time, either; the PCturbo allows a certain degree of concurrent operation, so that disk operations go on during computations, thus speeding up I/O (input/output). You will notice that there are other I/O speedups, too.

The 186 is *so* much faster than the 8088 that the disk controller is never waiting because the processor isn't ready for the next sector. I won't explain it here, but if you know what you're doing, you can reformat your hard disk with a smaller interleave factor, speeding things up even more.

You can buy the PCturbo 186 board with as little as 128K bytes of memory on it, but it won't work until you have 256K bytes, and it doesn't really work well until you have more. The software allows a RAM (random-access read/write memory) disk (fooling your computer into thinking that part of the system's memory is a very fast disk) and disk caching, so the PCturbo works best if you completely fill it. The total capacity of the board is 640K bytes.

The PCturbo 186 can't use your IBM PC's regular memory for running programs; only the memory on the PCturbo board is available for use by the 186 chip. However, the regular 8088 in the original IBM PC is still alive and active—it handles most of the I/O for the 186—and it can access whatever memory is available to it. Control is switched back and forth between the 186 and the 8088 through software.

The PCturbo will really shine with a hard or bubble-memory disk, since it can use disk caching. This is a bit different from a RAM disk: in a cache system, the computer watches what you're doing and keeps the stuff you use most often—specifically, the most frequently used disk sectors—in a chunk of memory known as cache memory. Orchid's PCturbo does this automatically; you don't have to understand it to make use of it. The disk cache is kept in the host IBM PC's memory (not in the memory available to the 186), which is why it's best to fill up the PCturbo 186 board with new chips and keep your IBM PC filled as well.

Memory is getting cheap nowadays anyway; California Digital is advertising 4164 chips at $5.25 in quantity 32, $4.95 in quan-

(continued)

Jerry Pournelle holds a doctorate in psychology and is a science-fiction writer who also earns a comfortable living writing about computers present and future.

tity 100 or more. Do recall that it takes 9 chips per bank of 64K bytes, since one is required to store the memory-checking parity bit.

Orchid's software allows caching for floppy disks, but this isn't smart since there's no way for the program to know when you have changed disks. Well, there is a way: you tell it every time you change disks. CP/M users won't find that strange. The problem is that with CP/M if you forgot to do a Control-C after changing disks, you got a BDOS (basic disk operating system) error; with Orchid's cache software, you probably lose all the files on the disk. This is nearly inevitable; after all, the most used sectors on the disk are the directory. If you change disks, the computer is still working with the (newly revised) directory for the *previous* disk, and when it goes to write—well, you get the idea. Best not to use cache memory with floppy disks unless you're *very* careful.

Another great feature of the PC-turbo 186 is that you can also use part of the original IBM PC's memory as a RAM disk. This is all explained in the Orchid installation manuals.

Of course, the manuals are fairly typical: I'm sure they explain how to configure your system for a RAM disk and other such goodies. I'm equally sure that I'll never figure it out. There is a file called OPTION, but when I ran that I got a series of orders about swapping disks, ending with a flashing signal saying "TEST IS GOOD"; that message could be exorcised only by turning the machine off.

The documents have no examples and a profusion of files (TURBO.SYS, RAMDISK.SYS, TURBEXEC.BAT), mostly empty or filled with nonsense; anyway, when you're reduced to typing out disk files for clues, you know you're in trouble. There are "explanations" that seem intentionally designed to be confusing. They show you an example to be placed in a file called CONFIG.SYS, but there is no such file on the boot system disk.

Fortunately, you need not understand any of this in order to get started. There is an Install program that will get the PCturbo system run-

ning; alas, the goodies like RAM disks and so forth seem reserved for those who understand Orchid's documents better than I do.

Once you do have it running, it goes well indeed. Most programs work fine with it. The one I've used most, I confess, is Cygnus's Star Fleet I game (I'm up to the rank of Commodore). This program is written in compiled BASICA and has no difficulties at all. The PCturbo 186 board really speeds things up, almost too much for some of the game messages. Because many games need precise timing loops, there's a simple way to drop out of the turbo mode and use your IBM PC in a normal manner.

Orchid provides a long list of programs that are claimed to be compatible with the turbo mode. These include Lotus 1-2-3 and Symphony; all Ashton-Tate software, including dBASE II; and Sorcim SuperCalc. We haven't tested all these; I have run Lotus 1-2-3, and you would not believe how fast the IBM PC with PCturbo will recalculate a spreadsheet.

When you invoke a program that cannot be run with PCturbo—BASICA is a good example—the machine reboots, or tries to. Usually it will succeed, but when I tried to bring up BASICA just now, it never finished running the start-up program; I got several messages, then nothing. Once again, the only remedy was to turn the machine off and back on.

The PCturbo board has a hardware reset button (which I've wished the IBM PC itself had) but only for itself. It doesn't reset the 8088 in the IBM PC, nor does it always work properly; once I got a message telling me to use the reset button on the PCturbo 186 board, but when I did it I was still locked out. The only certain remedy is to turn the power off and on—sigh.

I don't want things to sound worse than they are. I *like* this board. PCturbo runs *fast*. I've been using it with WordStar, which goes fine. WordStar 3.3 with the PCturbo 186 is so fast it scares me. Add Borland's Sidekick—which works *fine* with the PCturbo system—and I have a real temptation.

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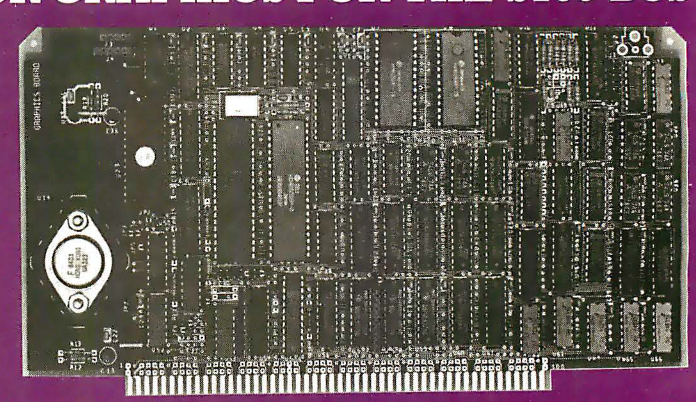


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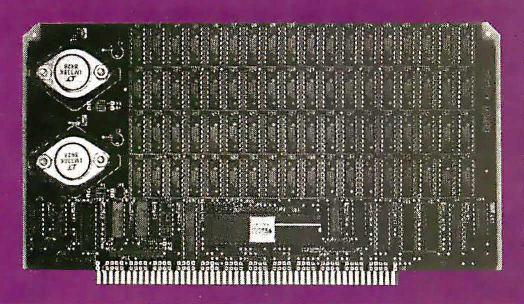
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I write a lot. What I use is a customized CompuPro Z80 system running WRITE, a text editor more or less customized by Tony Pietsch for me. It's fast, it's convenient, and I'm used to it. However, my rig does lack some frills.

First, it's an 8-bit system. So far that's no great hardship; there's still plenty of good 8-bit software. However, there's not likely to be much more. The real innovations will go to bigger and more powerful machines, for the simple reason that 8-bit systems cannot, without using kludgey tricks, address more than 64K bytes of memory.

Second, my system doesn't have Sidekick. For those few who don't know, Sidekick is a small demon program that sits up in an IBM PC or PC clone's high memory and provides you at all times with a calendar, notebook, calculator, and other goodies; if you're using an IBM PC without Sidekick, you don't know what you're missing.

My writing system also lacks graphics. I don't have on-screen underlining, on-screen **boldface**, and the like. What I do have is a *big* screen, 15 inches; and because my screen is driven by memory-mapped video (I'll explain in a moment), it scrolls smooth and *fast*. I'll trade all the graphics for that.

Still—WordStar 3.3 with PCturbo 186 scrolls just as fast as my memory map. The blinding speed of that Orchid board takes just about all the sting out of WordStar. The display isn't as good—I still prefer a *big* screen and white on black, not green, letters—but that's fixable. I'm sure someone makes an oversize video monitor that will eat what the IBM PC's monochrome board puts out; which would give me a big, fast screen with graphics goodies.

Bruce Tonkin has written a pretty nice terminal-emulator program for the IBM PC; I could use that to run a number of the other machines we keep here. It's *very* tempting to cut down on the number of screens and keyboards I face daily. I really am tempted to change over, since it's obvious that most of the compatibility problems will be taken care of in new releases of PCturbo software and documents.

Finally, there's ThinkTank, the idea processor. I don't have one for WRITE (or indeed for any 8-bit system), and I hate that; writers who don't use ThinkTank are working too hard. I can use ThinkTank on the IBM PC, then pipe the files across (in our case, we use the wonderful Disk Maker I from New Generation Systems: it not only converts disk formats, but from PC-DOS to CP/M); but it sure would be easier to do it all on one machine.

There are counterarguments. First, I keep hearing tales of a really splendid Concurrent PC-DOS that will run fine with big CompuPro 8/16 machines—and there are ways to speed the CompuPro up. See below.

Concurrent DOS is said to include 99 percent of PC-DOS within it, while letting you run four jobs at once. I would dearly love to be able to run PC-DOS programs, 8-bit programs, and CP/M-86 programs all at once; and even if they never get an 8/16 version of Concurrent PC-DOS, it's still good to be able to do more than one thing at a time. With true concurrency I could not only have the equivalent of Sidekick instantly available, but be using it while long jobs compile.

Tony Pietsch gets back from his European adventure—bicycling from above the Arctic Circle to Munich—this week, and once he's here I'm sure to get one of the new CompuPro IBM PC-compatible video boards. Given Concurrent PC-DOS, I'll have all the advantages of the PC and its PCturbo 186 and get to keep my custom keyboard and 8-inch disks as well.

Another reason I don't change is, alas, Magic Keyboard will not run with PCturbo 186. Magic Keyboard, you may recall, is a program that rearranges the wretched IBM PC keyboard so that the miserable " \ " key becomes a Shift and the infuriatingly placed "~" becomes a Return. (You can get " \ " and "~" by pressing the regular key plus Alt.) I won't use an IBM PC without Magic Keyboard or at least *something* to tame that stupid IBM PC keyboard.

Of course, there is an alternative. The Key Tronic KB 5151 keyboard works fine with both Sidekick and the PCturbo 186, and many will prefer the looks, heft, sound, and feel of the Key Tronic keyboard to the original keyboard supplied with the IBM PC. I happen to like the tactile characteristics of the genuine IBM keyboard (once tamed with Magic Keyboard); getting used to the Key Tronic wouldn't be that hard, but it would have to be done.

It's also possible that I'll get the authors of Magic Keyboard and Orchid's PCturbo together; Magic Keyboard *almost* works as it is, and it shouldn't take that much modification either to it or to PCturbo to take care of things. Orchid's list of compatible software includes Prokey 3.0.

When IBM brought out the AT, it was obvious that I would never want an IBM PC XT, and indeed IBM has pretty well slaughtered the XT market. I did think seriously of ordering an AT. I probably still will, but the Orchid PCturbo 186 board has taken the hurry out of the decision.

Documents Once More

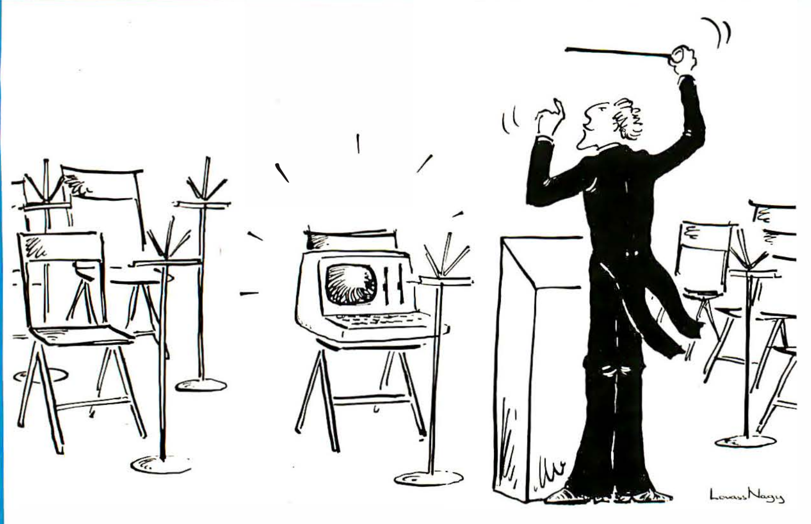
It's always a problem; we get something we like. It works, but the documents are wretched. The publisher is appalled. "We'll fix it! Really! Instantly!"

I even believe it. Now what? This column is built around reports of what we're doing here at Chaos Manor, and if what I've done is fight with a program because I can't understand the documents, then that's what I have to write about; yet I don't like to blast some publisher who really is trying to get his act together.

Oh. Well.

One remedy is obvious; all publishers should heed Pournelle's Law of Documentation: "You can't have too many examples." Take the Orchid PCturbo 186 documents. All Orchid needed to do was furnish several complete examples of systems configured in different ways. "System with two RAM-disk drives enabled, one

(continued)



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200K bytes, the other 100K bytes. Put the following files on the boot disk and include the following file in AUTOEXEC.BAT." List the exact contents of every required configuration file. If there can be problems about switch settings—apparently there can be—include examples of that, too. A few extra pages.

Another thing: Never Assume Too Much. Alex tells me that CONFIG.SYS is an *optional* file, one that is read automatically if included. I didn't know that. Orchid assumed that I had spelunked the DOS manual enough to know such things. Why should I? Will most IBM PC users do so? While I understand the counterargument: "If we assume you know nothing, we must recapitulate everything," examples can't hurt and will generally be enough.

After all, paper is cheap, and if you really understand your product, you're only talking about a couple of days' work having a naive user—someone who really doesn't understand the machine, possibly an engineer's spouse—follow the expert around and *watch* as the system is configured and brought up. A really naive user will ask lots of questions. "What did you just do? Why did you do that?"

Examples are sure cheaper than providing telephone support.

Orchid agrees and has fixed its documents.

MACROTECH'S MI-286

The other reason I don't convert to the IBM PC with PCturbo 186 is that I've been using Macrotech International's Z80h/80286/80287 processor board in my big CompuPro system. You talk about fast! That board is supersonic.

Way back in the dark ages, CompuPro brought out the Dual Processor 8/16 as a painless transition between 8-bit and 16-bit micro systems. The system had an 8-/8-bit 8085, which would run under CP/M 2.2, and a 16-/8-bit 8088, which could be run under CP/M-86. CompuPro and consultants then developed the 8/16 operating system, which let the faster 16-/8-bit 8088 handle disk operations and much of the housekeeping, so that even 8-bit programs ran faster.

When my friend Ezekial the Z80 finally expired, I was strongly tempted to replace him with a System 8/16; the only problem was that the 8/16 was at that time a development system that constantly changed, and I'm sufficiently paranoid as to want something stable when it comes to writing tools. The result was two systems: Zeke II, a CompuPro Z80, and the Golem, a CompuPro System 8/16. System 8/16s are now very reliable, and a lot of businesses use them; but mine, the Golem, remains truly experimental: he's absolutely stuffed with boards, and we often try out new boards and software on him. Zeke II, meanwhile, hasn't had the cover off for nearly two years.

A few months ago Tony installed a CompuPro 40-megabyte hard disk in the Golem. We also installed Tony's latest TMI BIOS (basic input/output system) software, including some revisions to the CP/M command processor. The machine runs with interrupt-driven I/O software and talks to the console at 19,200 bits per second (bps); the only reason we don't use a faster rate is that we've yet to find a terminal that can handle it.

In other words, my 8/16 is pretty advanced machinery.

In midsummer Tom Harincar, president of Macrotech International, came over to Chaos Manor with his new Dual Processor board. The Macrotech board uses an 8-/8-bit Z80h running at 8 MHz and the 80286 for greater-than-8-bit operations. (I don't want to get into the argument about just what the 80286 "really" is, so we'll leave it at that.) What Tom wanted to do was drop his board into the Golem.

"Well, I don't know," said I. "That machine is just chock-full of boards, and Tony has some pretty special software running in it . . ."

"It should be a good test," Tom said. "If my board will run with *your* system, it ought to go with any CompuPro S-100 system."

"Sounds reasonable."

(continued)

Thus started months of experimentation. Tom had brought Frank Nichols, his design engineer, who did the actual work. The first attempt didn't work at all. Nichols wanted to make modifications in my system. I wouldn't let him; we were not, after all, testing his capability to modify a CompuPro system; what I wanted to know was if an unmodified CompuPro system works with the Macrotech board.

The next attempt was closer. The board worked, but it didn't work for long. A month later, another attempt was made: this one worked for several days before it died.

Each time, though, things went smoother and faster.

Just before the World Science Fiction Convention over Labor Day weekend, Tom Harincar and Frank Nichols came back with two of their MI-286 Dual Processor boards. The idea was to take the lid off my CompuPro, remove the CompuPro Dual Processor's processor board, drop theirs in, and turn the system on; it should work.

It didn't, quite. Frank had to do a bit of fiddling. The fiddle, however, was to make a CompuPro-documented revision to the CompuPro System Support board (one of the chips needs to have one of the pins disabled). Once that was done, nothing else was required. My system, with CompuPro memory, CompuPro M-Drive/H, CompuPro Disk Controller and hard disk, and CompuPro I/O boards, running under Tony's unmodified software, works like a screaming bomb. I mean—it's *fast*. The floppy-disk operations take about 80 percent of the time they previously took. Computation using the 80287 math chip is so fast I'm going to have to invent new benchmark software; my reaction times aren't fast enough to time the system using my matrix multiplication "benchmark of sorts."

The 8-MHz Z80h is no slouch, either; all my 8-bit software runs faster, and because it makes use of the CompuPro 8/16 software, CP/M-80 programs have the same increased temporary program area (workspace) they had under the CompuPro processor.

In other words, the Macrotech MI-286 sounds too good to be true.

Bugs, Bugs, Bugs

When I first told Dr. Godbout about the Macrotech board, he said it *was* too good to be true. The Intel 80286 chip has a number of documented bugs; enough that Godbout sells *his* 80286 board as a development system.

When I put that to Macrotech's Frank Nichols, he agreed completely. There are a lot of bugs in presently delivered versions of the 286. "I de-


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signed around them," he said. "And not the way that IBM did with the AT, either. IBM can control the firmware and much of the software environment of the machine. I can't control what the user will do with our board, so I had to put logic on the board to compensate for the bugs."

Tom Harincar and Frank Nichols are proud of their MI-286 board. "It'll eat the IBM PC AT alive," Harincar says. "It's faster by a factor of four to three." He's very much looking forward to the time when the CompuPro video board will come out; that will make a CompuPro system with Macrotech MI-286 truly competitive with the PC AT.

The last time I spoke with Dr. Godbout he was still somewhat concerned about problems with the 286 and not convinced that Macrotech had done everything just right in interfacing the MI-286 board with the rest of the components of a CompuPro system.

I have no right to an opinion based on theoretical analysis. I can testify that I've had the Macrotech MI-286 running for more than a month now. It does spelling checks, runs Logitech's Modula-2 compiler, prints (including the 1000-page manuscript of *Footfall*), drives WRITE and other text editors, does calculations, runs BASIC, drives databases, and runs my accounting system. I've gradually come to depend on it more and more; my big CompuPro Dual Processor is, except for word processing, the most important machine I own; and the MI-286 makes it *fast*. I love it.

There have been no glitches. None. No disk retries, no hiccups, nothing of that sort. Macrotech says the MI-286 will also let you add more users to your MP/M-8/16 system. I believe that, but I have no firsthand experience; I don't use MP/M. The MI-286 sure jazzes up CP/M-8/16.

I'm going to keep using the MI-286. In fact, I'm just about to make an even more serious step: I'm going to convert Zeke II, my writing machine, to a Dual Processor using the Macrotech board. I haven't done that before in part because the CompuPro Dual Processor has an 8085 rather than a Z80, and there is some software—including Charlie Merrit's wonderful trapdoor public-key encryption system—that won't run without a Z80. Systems running under 8/16 have larger workspace and faster disk operations, but even so I've had insufficient incentive to tinker with Zeke II. That 8-MHz Z80h, plus the significantly faster floppy-disk operations, provides one.

So Why Don't You?

Macrotech advertises the MI-286 as "the 20-second revolution" because it takes about this long to change from

the 8085/8088 processor to it. "That's all there is to it," Macrotech says.

This is essentially true, but— There's always a but.

First, you have to be sure your CompuPro S-100 8/16 system is completely up to specs; if it's not standard—if there are wait states set in or there's been some software compromise with slightly nonstandard hardware—it may take a bit more time and considerably more knowledge to convert your system to the MI-286. That's not inevitable. It's likely to be as easy as the Macrotech advertisements say, and I've heard no complaints about Macrotech's support services. Still, be prepared.

Second, it *must* be an 8/16 system. Zeke II, the machine I'm writing this on, is not; he runs just fine under CP/M 2.2, but he's never been converted to any kind of 8/16 system. You must have the 8/16 software.

Third, you must have fast memory. If you are using (ahem) inexpensive dynamic memory, you must put in so many wait states that it's not worth it. All of the later CompuPro memory—all of the boards marked "816"—will work. Naturally, so will Macrotech's half-megabyte static RAM boards—but the 1-megabyte dynamic board won't work at all.

Fourth, the newest CompuPro software that can accommodate Concurrent CP/M and slave units will not work. You need an older version of the SW!.CMD program.

Fifth, I understand the real bugs in the 80286 chip show up when you have multiple users. If you're using MP/M and more than one terminal, be wary.

Given those cautions, it ought to be easy to convert to the MI-286. Thus, in theory I could simply configure Zeke II to match the Golem and use the same operating system for both.

In practice, it's much more difficult than that.

Remember earlier when I mentioned memory-mapped video? *That's* what Zeke II uses to communicate with me. What this means is that there's a board in there that looks like memory, but it takes what's in those memory cells and displays it on a monitor. Thus, to change my screen image, the software merely writes something new to memory. That's about the fastest operation a computer knows how to do, so the result is great speed in updating the video display.

The "software driver" that tells Zeke II how to do that is built into the CP/M 2.2 BIOS that runs the machine; and although I have the source code to that BIOS, it has been just long enough that I don't want to go hacking around on my own. Tony will be back soon enough, and I can get help from him. I hope.

And, finally, I do have some reluctance to mess about. "If it ain't broke, don't fix it" is awfully good advice. "Better is the enemy of good enough" is another statement I believe with all my heart.

The upshot is that I've got a second Macrotech MI-286 board. Tom Harincar is waiting for me to report that I'm using that board for all my writing. I mean to do it, too. Real Soon Now.

MORE THAN YOU'LL EVER KNOW...

On the subject of upgrading your IBM PC: Bob Brown, of an outfit called Landmark Software (1142 Pomegranate Court, Sunnyvale, CA 94087, (408) 733-4032), has a book—well, it's more than a booklet, if a bit smaller than a real book—called *About Hard Disks for the IBM PC*. It contains seventy-five 8½- by 11-inch single-spaced pages of solid information. (It's available for $25 plus tax and $2 for shipping and handling.)

Brown promises to tell you "more than you ever wanted to know" about selecting the right hard disk for your IBM PC, and he does just that. The

(continued)

book is written in English, too. Absolute beginners will find it a bit tough sledding; on the other hand, if you're a beginner, it might well pay to buy the book for your adviser. Alex now uses it as our reference work for IBM PC hard-disk problems: it explains things like the mysterious CONFIG.SYS, with its mystical "buffers =" statement; goes through different vendors and their strong and weak points, complete with addresses and phone numbers; and talks about boot ROMs (read-only memories) and the like.

The latest edition even includes IBM PC AT test results. It doesn't cover PC clones, but you can't have everything.

Brown hasn't quite Peter Norton's remarkable talents for explaining the complex with clarity, but he does write real English sentences and doesn't assume all that much. I confess I haven't read the whole book—it's not light reading—but I'm very glad we have it, and both Alex and I have no difficulty recommending it.

The Support Problem Revisited

Digital Research's people continue to provide free support for their products; they just don't do it by telephone any longer. If you want telephone support, you must subscribe to their Technical Support Service. Otherwise, use mail.

This doesn't seem unreasonable.

The support problem is a sticky one, particularly for companies that publish operating systems intended for a wide variety of machines. It's just not very easy to explain BDOS calls and how to hack a BIOS; there are whole books on those subjects, and reading one of those books, or otherwise conducting basic education classes in computer programming, is a pretty expensive proposition by telephone.

In the old days when most computer users were hobbyists, it made some sense for manufacturers to provide direct support; now, alas, I think we've outgrown that. There's no help for it: dealers will have to be the intermediaries. There are just too many users for Digital Research, or CompuPro, or Cromemco, or Microsoft, to provide telephone answerers for.

Pretty soon they won't be able to provide free support by mail, either.

The problem, of course, is that some companies continue to sell direct to the consumer—and thus *are* dealers—and many others have their products sold through discount houses operating on such a small margin that they can't possibly provide support.

If you buy your automobile at $10 above dealer's cost, you don't really expect a lot of help from that dealer, do you? Alas, the computer business has got there as well.

Thus, while I'll continue to try to

(continued)

help, I will *not* automatically intervene in every problem I get letters about. In the old days I could act as a sort of general ombudsman, and heaven knows I tried; but there are just too many problems, and many of them are not problems I can do anything about.

Pournelle's law: If you don't know what you're doing, deal with those who do—even if that costs more.

For Example...

Some months ago I wanted to add color to my IBM PC. (You can't run the wonderful KoalaPad paint stuff without color.) We have several Zenith ZVM-135 13-inch color monitors—about as good as you can get—so all I needed was a board for Lucy Van Pelt. We bought an STB Graphix Plus board from a discount house.

Alas.

The board wouldn't work with our monitor. When we returned it, the people we bought it from said it works fine—with an IBM color monitor. The board has both composite and RGB (red-green-blue) outputs, but it doesn't put color out the composite port.

More tests are in the works; they will, eventually, make the board work as I want it or give me my money back. I make no doubt I'll eventually have color, so we can hook up the KoalaPad, but so far we've used a couple of months; if I'd gone to a full-price dealer, I expect things would be settled by now.

The Clock Quest Concluded

Last month we reported on our quest for a clock board for Mrs. Pournelle's Z-150 PC clone (the Zenith people want me to call it the Heath/Zenith PC150, but that's just too much to write each time). We had bought an STB RIO Plus board, and it didn't work properly.

Blake Handler, Priority One's technical-support guru, figured out what the problem was.

The IBM PC normally has either 64K bytes or 256K bytes of memory on the motherboard, and the RIO Plus is set to add memory above those addresses. The Z-150 has 320K bytes of memory on its board; consequently, if you pack memory onto the RIO Plus, you must *leave the first bank blank*. (I don't know what would happen if you leave off the top bank on the Z-150; better to populate it fully and leave out the first bank on the RIO.)

The RIO's documents have this, and only this, to say: "Note that memory map 4 requires the memory chips on the RIO Plus board to be installed starting in row #2 if all six rows of memory chips are not implemented." This accompanies a diagram and text of remarkable obscurity; it took the Priority One technicians about two weeks to figure out what was wrong.

The RIO's parallel port must be configured as LPT2. There's also a potential problem with the RIO's serial port: if your Z-150 already has two communications ports, then the one on the RIO Plus board must be disabled. STB sells a chip, PLSNOS, which you plug into the board to accomplish that. This is a PAL (programmable array logic) chip, and you *must* use it if you want to disable the RIO's serial port; that cannot be done with switches. This means that if you want an RIO Plus for your Z-150, or any other computer with two serial ports, you *must*

(continued)

Items Discussed

Aris $395
Excel Systems Corp.
655 Redwood Highway
Suite 311
Mill Valley, CA 94941
(415) 381-4410

CompuPro 8/16 System $5995
CompuPro
3506 Breakwater Court
Hayward, CA 94545
(415) 786-0909

dBASE III $695
Ashton-Tate
10150 West Jefferson Blvd.
Culver City, CA 90230
(213) 204-5570

Elsinore $19.50
Safari $19.50
Magic Keyboard $32.50
Workman and Associates
112 Marion Ave.
Pasadena, CA 91106
(818) 796-4401

MI-286 Processor Board ... $1395
Macrotech International Corp.
9551 Irondale Ave.
Chatsworth, CA 91311
(818) 700-1501

PCturbo 186 Expansion Board .... from $1095 (128K bytes) to $1970 (640K bytes)
Orchid Technology
47790 Westinghouse Dr.
Fremont, CA 94539
(415) 490-8586

RIO Plus Board
64K bytes $395
384K bytes $845
STB Systems Inc.
601 North Glenville
Richardson, TX 75081
(214) 234-8750

Sprinter $795
Micro Peripherals Inc.
4426 South Century Dr.
Salt Lake City, UT 84107
(801) 263-3081

SuperDex Document-Indexing Software $59.95
Spite Software
13531 SE Foster Place
Portland, OR 97236
(503) 224-0137

Tax Shelter Eater $150
Tax Tech
4038 Coolidge Ave.
Los Angeles, CA 90066
(213) 201-8911

UNIX Pascal Compiler Source Code $7500
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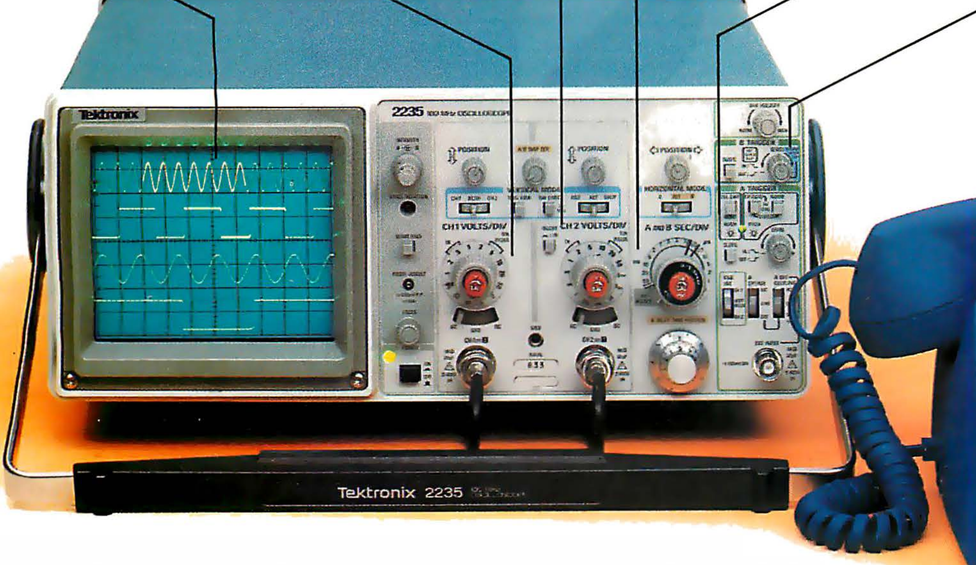
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order the PAL chip at the same time. In the unlikely event that your Z-150 has only one serial port—two come standard—address the RIO's serial port as COM2.

The RIO Plus has a number of nice features, including the ability to connect two game paddles—Apple game paddles would work. We like the board, but the documents need revision. Rewriting would be better. There's no reason why STB can't explicitly state the potential problems with PC clones.

The memory-conflict problem is likely to be generic for all manufacturers: most PC-compatible boards are going to conform to the IBM PC memory pattern, so Z-150 owners should be wary, as should anyone else with a clone that doesn't have exactly 64K bytes or 256K bytes of memory on the motherboard.

SPRINTING

We've mentioned MPI printers before. We're now in a position to state that they're pretty rugged.

Last week Alex hooked up the serially configured MPI Sprinter to the Z-150; alas, he hooked it to the parallel port. It doesn't seem to have hurt anything. Didn't work, of course.

The printer works fine now that it has been connected to the serial port. We did have to swap pins 2 and 3 in the Sprinter's cable; we did *not* have to do that to get it to run on the Otrona Attache.

I've never really understood the RS-232C "standard" connectors and certainly never understood when you have to swap wires in a cable. The only real solution I know of to the problem is to get an RS-232C "breakout box," which looks like a cable with a plastic box in the middle; inside the plastic box are pins and jacks that let you reconfigure the cable. Given one of these, good documents, and plenty of time, you can generally manage to make serial connections, provided the phase of the moon isn't too unfavorable and you hold your mouth right.

DO YOU REALLY NEED SHELTER?

There are about a zillion tax shelters offered for sale. I'm no financial wizard, but all the investment brokers I know counsel lots of caution for those contemplating buying one of these things. The advertisements promise wealth untold and the riches of Croesus, all at the expense of the government; but the realities can be quite different.

Comes now the Tax Shelter Eater.

This is a program by attorney Schuyler Moore, member of a prestigious Los Angeles (Century City) law firm. The version I have runs on an IBM PC; I'm told there's also one for Apple DOS 3.3.

This program analyzes tax-shelter

The Tax Shelter Eater analyzes tax-shelter offers.

offers. It does it by asking you questions; if you can't answer those questions, you've no business buying into a tax shelter in the first place. If you got nothing from the program but the questions it asks, you'd probably be ahead.

Alas, that's about all I can say about it. I'm no investment counselor. You don't need a Pepperdine M.B.A. to understand the financial theory that comes with the program, but it wouldn't hurt, either. One of my friends who does have an M.B.A. says it looks like a pretty good program.

I mention the Tax Shelter Eater because I've seen friends get burned by odd tax-shelter investments. If they'd had this program and followed its advice, they wouldn't have. Fair warning, though: for all I know the program might cause you to miss out on a good deal, and I cannot possibly know whether it would reject all the bad ones.

Use it at your risk, not mine.

ARIS

One reason I want an IBM PC-compatible machine is that all the new integrated software is being written for them. I don't know whether Aris is the program I really want to use—there are a lot of them, and I haven't had a chance to test many—but it certainly has many of the characteristics of the "Executive Secretary" program I put on my wish list three years ago.

Aris bills itself as a "personal work processor." It integrates your spreadsheet, a word processor, printing, phone answerer, etc., into one program. It's a desk-replacement program, though—its word processor isn't designed to compete with WordStar, and you use your own spreadsheet. Instead, they are all for "run-

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ning your business life": taking down phone notes, writing a simple letter, balancing payments, etc.

At least, that's what a first glance showed me. There are bugs—especially in the word processor. For instance, you cannot press Return to go to a blank line below unless you are in insert mode. Mode-oriented editors have never been among my favorites anyway.

On the other hand, you can use your favorite word processor; you're not stuck with the one built into Aris.

A few random observations: Aris works much better with a hard disk and lots of memory than with a machine with two floppy disks, but that will be true of all the "executive-assistant" type programs. Alas, there is no single "bailout key" that gets you out of the current function, although Esc comes close. If there are no assignments to print out, Aris says "no matching assignments" instead of "there are no assignments."

Aris provides an interesting contrast to Sidekick. Instead of one program you can call up at any time, Aris is one program from which you can call others. Of course, that means you must use its command structure.

The appointment calendar is called a "diary," and I couldn't find it at first. It's pretty neat and keeps track of time, and work-assignment due dates, and the like.

The Aris documents are obviously preliminary. The manual needs to be typeset, indexed, and longer. It's a good start to a tutorial and manual, but it's nowhere near complete. Excel seems to be primarily concerned with Aris, and the program advertisements say the program was written by the company's President Krista LaBianca, so I expect there will be improvements in both software and documents.

The program comes in fairly elegant packaging. It is *not* copy-protected; the documents urge you to make backup copies immediately. This is a very large plus over some of the better-advertised programs.

Aris has considerable promise, but

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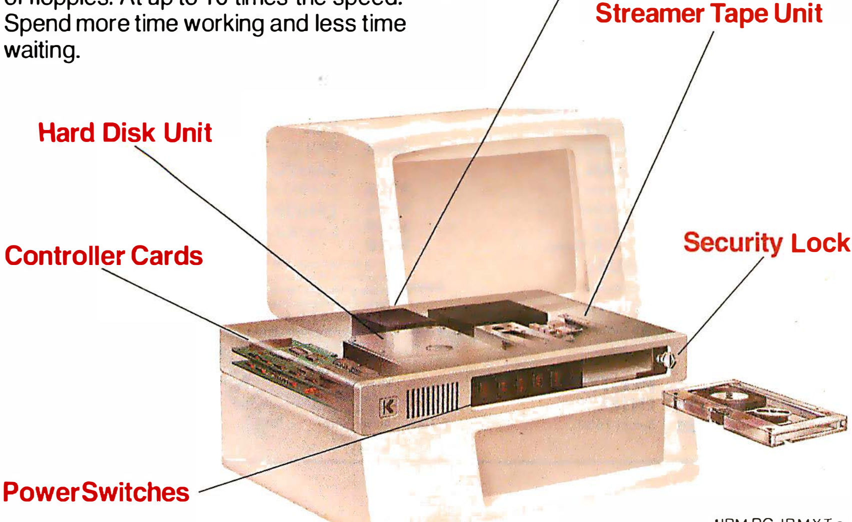
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it needs work. More when I've played with it more or have an update.

Excel says it's doing new documents now.

WELL, IT'S A STEP UP . . .

AT&T recently sent around an announcement of a new UNIX Pascal compiler to run on the AT&T 3B computer series. The compiler is said to have lots of goodies, including separate compilation, hooks into UNIX utilities, and the ability to call programs written in C.

The price for source code is $7500 ($2000 for qualified educational institutions). This isn't cheap, but it's pretty reasonable compared to the goofy prices AT&T wanted last year for the COBOL syntax checker.

I'm less convinced than I was last January, but I still believe the AT&T 3B2/300 has the potential to be one of the most important microcomputers of the future; certainly the more languages AT&T has, the better its chance.

THE BACK ROOM

The back room at Chaos Manor is filled with computers: the Apple, an Atari, a Corvus Concept, Zorro the Z-100 with his attached wonderful Disk Maker I that can read and write more than 100 disk formats, and any number of other machines. In the center of it all sits Peter Flynn and Shirley (officially known as a CompuPro 10).

One of Peter's jobs is indexing books. After his problems with my first computer book (see the October 1984 BYTE, "The Index Dilemma," page 332), we got a new version of SuperDex with faster screen I/O. The theory is that you go through a WordStar copy of your manuscript marking words and phrases with Control-P, after which SuperDex does, if not all, then much of the work.

Peter didn't use that approach. Instead, he made a paper copy using WRITE. With our HP LaserJet printer, that's a fairly quick and easy thing to do. Then he brought up WRITE on Shirley and proceeded to page through the paper copy making notes that look like

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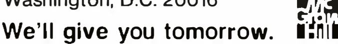
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S>Subheading
@>57
P>another major head
@>57
P>Yet another major
S>corresponding minor
@>60

and so forth. This creates the "raw index" file wanted by SuperDex; the program takes it from there and prints out quite a nice-looking index keyed to the paper copy. Now our publisher's copy editor can take the typeset page proofs and our index and finish the job.

Peter says this works better than the primary method recommended by SuperDex. For one thing, he would have to convert from a series of WRITE files into one big WordStar file; and WordStar is pretty slow even running on Shirley. (Next time he can, I suppose, use WordStar 3.3 on our IBM PC with the PCturbo 186; we'll see.) For another, simply scrolling through the manuscript marking pages won't give you an index entry for, say, "future of computers" on a page that never actually uses that phrase.

As Peter notes, what he's doing is a bit like the old-fashioned method of indexing with a card-file box, but using the computer to write the card entries, file them, sort them, then format and print out the index; much easier. He does wish he had a program that would give him a current list of indexed words and phrases. (Of course, he *can* from time to time print out the partial index already made, but it won't be on line—ha! Phrases it won't do, but The Word Plus has a program that will make an alphabetized list of unique words; aim that at the "raw index" file.) He would also like a computerized way to handle multiple listings, as, for example, each computer to be indexed under its own company name as well as being subheads under "computer."

Indexing is still as much art as science, but computers sure make it a lot easier.

Go for It

We just received a new copy of Ashton-Tate's dBASE III. I haven't had a chance to do more than put it into Lucy Van Pelt and determine that it does come up, and it does seem to work with PCturbo 186.

The manuals look much improved over the old dBASE II (Vulcan) manuals, and there seem to be a lot of nice features. I don't know how many of those I'll learn, because, alas, dBASE III is copy-protected. I used dBASE II for years; it wasn't copy-protected and indeed urged you to make backup copies.

The scheme of copy protection (1) puts a number of bad sectors on the disk and (2) won't let you use the program on a hard disk without the original system disk. Moreover, when we were trying to determine whether we could run dBASE III with PCturbo 186, we crashed it; I'm not sure how, but now the dBASE III master locks up the machine when we try to run it. It may be that we had a defective disk to begin with; when you deliberately put bad sectors on a disk, it's pretty hard to devise good quality-assurance procedures.

We have dBASE III running under the backup disk provided, but this is absurd.

The only good news is that dBASE III is copy-protected with one of those "unbreakable" systems, meaning that it took the crackers almost three weeks to break it; I'm reliably informed that a number of dealers will give you a copy of the backup program when you buy your regular copy. There are other ways to defeat the copy protection if you have a hard disk.

However, most business owners will not want to fool with demons and unauthorized copies; it will be interesting to see how many will entrust their business records, including all their inventories and accounts, to the frailties of a floppy disk—and that is precisely what Ashton-Tate is inviting them to do. Just think, you too can be at the mercy of kittens, telephones (one good way to lunch a disk is to put it under the phone and wait for it to ring), coffee, magnetic paper-clip holders, and other such goodies. Me, I think I'll stick to my own accounting system and dBASE II.

One of the Ashton-Tate programmers tells me that dBASE III was developed in C on a VAX, so there is obviously a version that will run on a VAX. Ashton-Tate's people don't know what to do with it. One possibility is to market it, but the problem would be to provide support; they don't have that many VAX wizards. If they go this route, it will be interesting to see what they sell it for: recall the database program that sells for $500 to run under PC-DOS and $98,000 to run on an IBM mainframe.

Another thought they've had is to market the VAX version unsupported for the price of the distribution tape. If they want my opinion, that's the route they ought to go. They'll get an awful lot of students, hackers, wizards, and general VAX users accustomed to dBASE III; it won't be hard to guess what program they'll get for their own computers and recommend to their friends.

Of course, if they want my advice they'll get rid of the stupid copy protection, too. Ashton-Tate made a lot of money with dBASE II while remaining good guys; why do they want to go spoil it now?

Winding Down

There are several recommended books this month. First, *The Odyssey File* by Arthur C. Clarke (Ballantine Books, 1984, $3.95) details his conversations, by modem, from Sri Lanka as he was setting up his system, writing books, and working with the director of *2010*. Amusing, instructive, and fun.

(continued)

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Software for the Macintosh continues to be more potential than real.

The *Omni Complete Catalog of Computer Software* edited by Owen Davies (Collier Books, 1984, $23.99 hardcover, $13.95 paperback) is well worth your attention. The reviews are a bit uneven. With darned near 1000 programs reviewed, how could it be otherwise? They are, for the most part, very fair, and I found few to disagree with. Coverage is also spotty—it would have to be—but they don't just review the biggies. For example, there is a very fair treatment of WRITE, my favorite (if a bit obscure) text editor, and it includes a number of other smaller programs, including several I never heard of but have decided I want to look at. Recommended.

Structure and Interpretation of Computer Programs by Harold Abelson, Gerald Sussman, and Julie Sussman (McGraw-Hill, $32.50) is written by the people who teach the MIT course of the same name; this is traditionally the first computer course at MIT for computer-science and electronics-engineering majors.

If you hate Pascal and love LISP, you'll like this book. If you don't know much about either Pascal or LISP, you will not get an objective treatment. The authors say: "In teaching our material we use a dialect of the programming language LISP. We never teach the language, because we don't have to. We just use it, and students pick it up in a few days."

That may happen at MIT. It hasn't happened yet for me.

The preface of the book is by Alan Perlis and contains this sentence: "The discretionary exportable functionality entrusted to the individual Lisp programmer is more than an order of magnitude greater than that to be found within Pascal enterprises."

Fortunately, the rest of the book is somewhat clearer. *Structure and Interpretation* is a frustrating book; I get the distinct impression that if I could just go through it (possibly by taking a month off to plow through without interruptions) I'd learn a lot; but so far enlightenment has eluded me.

Two games of the month are Safari and Elsinore, both for the IBM PC and sold by Workman. They're Adventure-type games (no graphics, just script) written by Dian Girard. My personal game of the month was Millionaire on the Macintosh; the Mac is very well suited to that kind of game. Incidentally, Workman reports that replacement door latches for the Tandon disk drives on the IBM PC are one of his hottest selling items.

Macintosh software continues to be more potential than real. I've even signed a bunch of papers, although I've yet to get much actual software. The 512K-byte memory expansion is now available and we've ordered ours; I suspect that when Fat Mac becomes widely available we'll finally see some of that promised flood of programs.

As usual, I'm out of time and space, but there's much to cover. Next time I'll try to get to the new Sage VI, which is now officially known as the Stride 460; Sage Computer has now become Stride Micro. Alex says the name reminds him of "the really great coffee with the really ugly label." I can't say the new name instantly appealed to me, either. I do like the new line of computers, which run at 10 MHz and sell for prices ranging from $2900 to nearly $60,000 for an all-up 448-megabyte system.

David Gerrold says the micro revolution "shambles" onward. Maybe for him. Me, I feel like I've been run over by the Bullet Train . . . ■

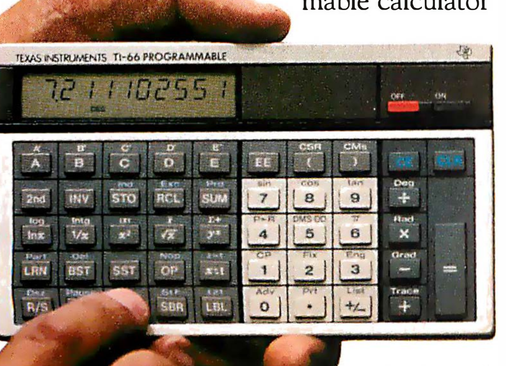
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The Portable has plenty of capacity; 272K bytes of RAM and 384K bytes of ROM. And with its built-in modem, it can link you with your office printers and plotters. Not bad for a computer that weighs just nine pounds and can fit into a briefcase.

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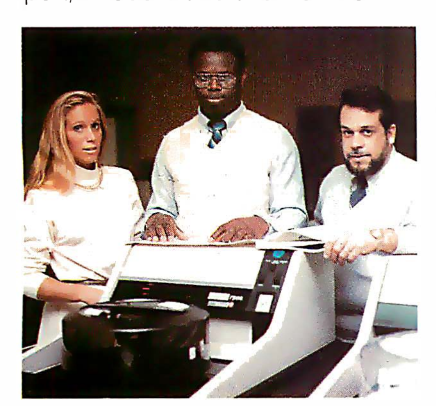
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Inquiry 161

Submarine Engineering. Tomorrow is today at NUSC

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"I got responsibility right away," says Ronald Jackson, an electronic engineer. "As I showed ability, my responsibility grew. Today, I'm a project engineer." Through NUSC's liberal education policy, Ron has earned a master's since he joined Newport and is working toward a Ph.D.

Because the Center helps its scientists become expert in other fields, electronic engineer Donna Doane is concentrating on computer software. "I'm doing things people never have done before," Donna says. "I design the project, and I see it to the end—to the final product." Monica Sachs is learning something new each day. "I'm working on weapons systems engineering, a broad subject that allows you to get into several different kinds of engineering. I use my electronic engineering background to understand the other disciplines." And Peter Santiago applies his computer background to quality assurance. "I look for self-gratification in the job, and I get that at NUSC."

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More MacLetters

Dear Jerry,

As an avid BYTE reader, I generally find the shoot-from-the-hip style of your column both informative and entertaining. Alas, your stabs at the Macintosh in the July 1984 BYTE ("Big Mac," page 312) had neither characteristic for anyone who knows that excellent machine. Your comments on the lack of Macintosh applications at the West Coast Computer Faire (July, "The Big Mac," page 376) completely miss the point. It is of course true that just two months after its introduction a machine that attempts something really new and thereby spurns compatibility with existing systems will have little written for it. But what of the ease of use of the machine, its speed and flexibility, and future software?

In fact, MacWrite is fast, powerful, and easy to learn. As a university professor, I have watched in dismay as secretaries suffered through WordStar on the office IBM PC. It is a real thrill to see how quickly they can pick up MacWrite and how they enjoy the restful screen, the easy formatting, and the magnificent flexibility of the Mac (try doing French in WordStar, Jerry!); the high-quality mode on the printer produces a very pleasing typescript. By July we had Multiplan up and running beautifully (the bug in the first release having long since been corrected) and were eagerly awaiting Microsoft Chart, which will combine with the Imagewriter printer to produce knockout graphics already evident in MacPaint. And all this without the expense and bother of running separate monitors and/or adapter cards for graphics, as one must for the IBM PC.

And what does BYTE have to say about *all* this, apart from the superb and balanced preview by Gregg Williams in the February 1984 issue? Not much. You say it takes two minutes to call MacWrite, and the July editorial by Phil Lemmons complains that it takes three selections to eject a disk. I timed my 11-year-old son, who is an eager Mac user, on these operations: 50 seconds to enter a specific MacWrite document from the time the power is first turned on; 12 seconds to eject a disk starting from the desktop. For many operations in word processing and spreadsheets, the mouse is much faster than cursor keys (note the large sums of money people are paying to attach a mouse to existing PCs).

Indeed, to paint the Mac a slow or inflexible machine for the average user is the reverse of the truth. Yet when a Macintosh owner writes to ask you to join him in criticizing Microsoft for its copy-protection format on Mac Multiplan ("maybe Microsoft will listen to you"), you respond by attacking the Mac! Those of us using the superb Mac version of Multiplan in an office setting can only grind our teeth in dismay and amazement when you refer to it as "an expensive toy" that is "Macuseless for business."

The Apple people did make one big mistake, for which you and many other reviewers have rightly chastised them: the original model should have had 256K bytes of RAM. By resisting the IBM-compatibility bandwagon, the Mac owner therefore runs a risk, but I bet it's one that pays off. I wager that soon the Mac with 512K bytes will have a large supply of superb software, while many of the IBM clones and compatibles will face declining sales and/or imminent bankruptcy.

Paul Davenport
Montreal, Quebec, Canada

Sigh. If Macintoshes were free, we'd have no quarrel. Indeed, I've said before that if you can get one at the heavily discounted university price, you should think about that seriously.

On the other hand, in my judgment you can get more bang for the buck with some other machine. That may not always be true, but I think it's true now.

I don't know what to say about the Microsoft copy protection of Multiplan. I don't like copy protection, and I'd think everyone south of Oshkosh would know that. Alas, I don't think Microsoft is going to change policies because of me. It's just too easy to copy-protect Mac disks.

As to doing French in WordStar, thank you, no; of course, a Mac won't help either, since French is what my parents spoke when they didn't want me to understand.

Stay well.—Jerry

Dear Jerry,

As an owner of a Macintosh, having but recently come to the world of the personal computer, I was interested in your comments in your August 1984 column (page 313).

It is difficult to understand why the Macintosh manual and the books I have read are so poorly written and so lacking in vital information. To make matters worse, the commercials for the Mac that I saw on TV during the Olympics actually dwell upon the fact that the manual is small compared with the competition. To my way of thinking, this is not an advantage to be advertised but a serious disadvantage that needs immediate correction. One would expect that Apple would be making every effort to correct the matter instead of using it as advertising copy.

For example, some of "the rest of us" are interested in how to fix a disk that has "bombed." I experienced two "bombed" disks within the first two weeks of Macintosh ownership and only a chance reading of a magazine article gave me the answer.

While the Macintosh does what I want it to do, I would still like to be provided with a detailed, correct, and thorough manual. It is irritating, when setting up simple programs in BASIC, to have to work through feature after feature by trial and error. This computer has not been well served by its documentation, and I appreciated your comments. Perhaps in the near future, Apple will undertake a serious reexamination of its objectives for the Macintosh and make a new manual one of its high-priority projects.

Charles S. Allyn
Pauma Valley, CA

Agreed. There are a lot of "features" about the Macintosh that seem inspired more by ideology than anything else.
—Jerry

Perfect Writer

Dear Jerry,

I read with interest your problems involving indexing and other jobs using WRITE and WordStar. I think that you

(continued)

might want to look at some of the features of Perfect Writer.

I received Perfect Writer as part of a Kaypro package a year ago and have grown to like it. For example, it has indexing already built into the basic program. As you write, you can include an index command and a reference word(s), and Perfect Writer automatically will make an alphabetized index of subjects and the pages on which they appear. Perfect Writer also will create a table of contents if you desire, with chapters, sections, subsections, and even paragraphs. Perfect Writer also can print automatically numbered footnotes on the bottom of each page or references listed at the end of the document.

Although Perfect Writer is not compatible with WordStar, it can be made compatible by judicious use of the PIP command or probably by a program such as FILTER.COM. (Of course, a program such as Footnote is superfluous to Perfect Writer users.) Perfect Writer is not the "in" program these days it seems, but it does have some interesting features.

ROBERT J. SCHECHTER
Los Angeles, CA

You're hardly the only one who likes Perfect Writer, which does have a number of features. I don't use it myself; and one reason it isn't the "in" program is that you have to know some of its idiosyncrasies before you're totally safe from text-losing blunders.

Thanks.—Jerry

PRINTERS

Dear Jerry,

Concerning your quote ". . .one day we'll be able to replace both the office copier and the printer with one device" ("Electrostatic Printers," July 1984, page 328), IBM has already achieved this goal with its 6670 (Models I and II) laser printers that double as convenience copiers.

TONY PATTI
Arlington, VA

Yeah, IBM sure has, but to buy one you'll need scientific notation to write the price and a government subsidy to pay it.
—Jerry

THE SCIENTISTS STRIKE BACK

Dear Jerry,

Ye gods and little fishes! Talk about turning a nonproblem into pandemia. APL to do complex arithmetic—and data typing yet? What is all this talk? You are (sob!) beginning to sound like one of those (aaargh!) computer high priests. Steve Maas posed a valid point about the widespread use of complex arithmetic in science and engineering ("Scientific Computing," August 1984, page 334). For microcomputer users your suggestions had about as much practicality as proposing to do sums and differences on a slide rule. Who has, and at what price, APL for microcomputers?

If a language can handle trig and log functions, it can be used to do complex arithmetic (provided it can recognize the difference between a character and an integer). Most microcomputer BASICs have these capabilities. What you should have told Mr. Maas is to put together a set of subroutines to perform addition, subtraction, inversion, and square roots of complex numbers in BASIC and deal with his inversion of a matrix of complex numbers.

I do all this and more (e.g., complex hyperbolic functions) on a Sharp PC-1500 hand-held computer. To show the simplicity, here are the BASIC statements for multiplication of complex numbers:

```
REM: (S + j T) * (U + j V)
"MULT": W0 = (S * U) - (T * V) :
          T = (S * V) + (T * U)
          S = W0 : RETURN
```

This subroutine is entered with the variables S and T containing the real and imaginary parts of the first complex number, and U and V, respectively, for the second complex number. The product is returned in S and T. W0 is a temporary variable.

The remaining functions are similarly succinct and not at all difficult. APL indeed!

FORREST GEHRKE
Mountain Lakes, NJ

Ah, well, you see I have this mad desire to play about with APL, and the (theoretical) problem posed to me prompted me to say I'd use APL to work the problem.

Actually, like you, I'd very probably use BASIC, which I understand and have at hand.

Thanks.—Jerry

Dear Jerry,

I have been using Pascal for scientific computing for several years, and I couldn't resist writing. FORTRAN was the first language that I learned (more than 10 years ago), while I have known Pascal for only the past four. My scientific-computing needs include numerical simulation, statistics, and the analysis of experimental data. Yet my preferred language for such work is Pascal, and I will use it when writing a new program unless I have an explicit reason not to. (One such reason is when the program must be used on several mainframes. Alas, not many mainframes have a very good implementation of Pascal; no one thinks it's suitable for scientific computing.)

I did a survey of my disk directories and found that of 420 programs, packages, and library routines, literally half of them were written in Pascal and the other half in FORTRAN. I now use FORTRAN for scientific computing like I use BASIC—only when I have no other choice.

On another note, I'd like to let you know of a rather horrifying experience that I recently had at several computer stores. First, I should let you know that my personal computing experience is with homebrew hardware and software (including operating-system and language implementations), and I understand the point of view of a friend of mine who once said that it was all over when they started carpeting the floors of computer shops. After all, who would ever walk around such a place with bare chips in their hands! Anyway, I wasn't looking for anything too exotic—just an ordinary RS-232C cable with a 25-pin subminiature D connector that was male on both ends. Because I needed the cable in order to connect a terminal to a modem, the cable didn't even need all 25 pins wired (just 1 through 8 and pin 20 would do). Sound simple? I usually get such things from one of several mail-order sources, but I was in a hurry.

The first three places I went to asked what kind of computer I wanted to connect to. When I told them just an ordinary terminal, they looked at me like I was from Mars. A fourth place said that they had heard of such cables, but the store manager told me—with a straight face—that it was not a standard cable and the industry was phasing it out! Start hoarding those cables now! Anyway, in a panic I found another shop. They said that they thought that they could help. The salesman looked around for the one guy in the shop that knows what's in the back room, and *he* found them in the basement. They even had two cables, which I wanted. The only catch was that they wanted $55 apiece for them. This was turning into a nightmare. I eventually gave up and went

(continued)

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back to my mail-order sources. One of them, Inmac, which is a premium-price, premium-quality place with a superfast delivery time (about 18 hours for me), had the identical cable for about $35. And I found ribbon-cable versions for less than $25 from several sources.

I'm not sure what circumstances could now drag me into a typical computer shop. Those people remind me of a used-car salesman I once knew.

EVERETT CARTER

Your letter is typical: lots of people familiar with both FORTRAN and Pascal (or Modula-2) prefer the highly structured languages for number crunching.

I've had good experiences with Inmac. You can find stuff at lower prices, but I've had fast and reliable service.—Jerry

LOOKING FOR A PASCAL

Dear Jerry,

I am interested in buying a Pascal for my Morrow MD2, but I don't think JRT is good enough, and Borland's Turbo doesn't come in the right DOS. A recent Ellis Computing ad in BYTE included the addition of Nevada Pascal to its line of products.

I sent for a catalog hoping to learn more about it, but I received the same catalog that I had before, without the Pascal. I am left almost totally ignorant as to what Nevada Pascal is like. Since you seem to be an expert on Pascal, why don't you do a review of Nevada Pascal?

ANDY MARKEN
Columbia City, IN

Alas, the Ellis Nevada Pascal is *JRT Pascal (version 3.0), or so I've been told.*
—Jerry

TK!SOLVER

Dear Jerry,

I have been reading for some time of the Japanese fifth-generation computer and of nonalgorithmic languages. I thought I would let you know that I have been using such a language for a couple of months. It is called TK!Solver, and it's wonderful. It solves problems that can be modeled as algebraic equations.

About six months ago I had to design a three-port network with five unknown resistors, subject to five constraints. The equations were nonlinear, involving sums of reciprocals of the resistors. Using various mathematical tricks, I reduced the problem to three equations in three unknowns and then wrote a FORTRAN program to help evaluate the equations as I searched a three-dimensional space for an answer. I am a computer user, not a computer programmer, and the inevitable bugs took their toll. I finally got my answer after 40 man-hours. Was it worth it? Yes, the payback over the life of the product will cover the cost. Would I have spent the 40 hours if I had known it would take that long? No, a more expensive solution was available, and there were more important problems to solve.

Well, about two months ago, some fellows down the hall bought TK!Solver and put it to work evaluating some straightforward equations and making

some plots. It looked interesting, and I looked through the manual. After two hours, I decided to try the three-port problem on it as a test. Four hours after I picked up the manual, I had a solution. A 10:1 improvement. Actually, more than 10:1 when you consider my years of FORTRAN experience and no experience with TK!Solver.

Now I use the TK!Solver program frequently. I have several of my favorite active filters programmed into it. I just enter the desired center frequency, Q, gain, and capacitor values, and TK!Solver calculates the required resistors.

This program is going to do to algebra what calculators have done to arithmetic. You ought to try it.

Any complaints? A few. It does not handle complex numbers. (Laplace transforms have to wait.) The control structure lacks orthogonality. Some commands are invoked by special characters, some from a menu, and some by typing things in special fields.

I really enjoy your column.

ROY MCCAMMON
Austin, TX

I've previously reviewed TK!Solver, and I agree: it can do wonders for my ability to work algebra problems. The manuals leave a bit to be desired, but if you study them hard you'll figure out how to use the program—and it certainly works. —Jerry

TOM TCIMPIDIS

Dear Jerry,

As a follow-up on your comments in September 1984 ("The RCBS Blues," page 368), you may be interested in this message from Tom Tcimpidis's bulletin board (see figure 1).

MERVIN E. FRANK
Santa Ana, CA

```
FROM MOG-URS BULLETIN BOARD
  (818) 366-1238

MSG #10705 ON 08/29/84 AT 00:49:04
FROM: SYSOP    (1)
TO: ALL
SUBJECT: THE MOG-UR BATTLE WITH PACTEL/POLICE MAY NOT BE OVER
YET!    8

     I HAVE RECEIVED WORD THAT THE L.A. CITY ATTORNEY HAS, WITHOUT
ANY ADVANCE WORD NOR ANY INDICATION OF REASON, INDICATED THAT HE
INTENDS TO FILE CHARGES UNDER SECTION 502 (?). CHARLES LINDNER, MY AT-
TORNEY, WAS NOTIFIED OF THIS TODAY AND WILL ATTEMPT TO FIND OUT
WHAT IS TRANSPIRING.
     I WILL KEEP EVERYONE INFORMED AS INFORMATION BECOMES
AVAILABLE. THE FIGHT MAY NOT BE OVER YET (UNFORTUNATELY)!
                                        -TOM

  END OF MSG # 10705 FROM SYSOP    (1)
```

Figure 1: *Message from Tom Tcimpidis's bulletin board.*

I understand that Pacific Telephone and the Los Angeles City Attorney held a meeting to which neither Tom Tcimpidis nor his attorney were invited; and after that meeting, the City Attorney changed his mind and decided to prosecute Tom because some wag had put telephone access codes on Tom's public bulletin board. Tom's bulletin board can be reached at (818) 366-1238.

Those interested can send funds for Tom's defense to Lynzie's Motherboard, POB 284, North Hollywood, CA 91603. The address of the Los Angeles City Attorney is Ira Reiner, Los Angeles City Attorney, Suite 2000, 200 North Main St., Los Angeles, CA 90012.

When I talked to Pacific Telephone officials, they swore they wanted to find a reasonable settlement to the conflict of interest between the free flow of information and protecting their property rights; this seems an odd way to go about it.—Jerry

ENCRYPTED SOFTWARE

Dear Jerry,

Be patient. Only a few more years of copy protection and software piracy remain. Soon, microprocessors will be able to run encrypted software. Each processor will come with its own encryption key. When ordering software, you give the key over the phone to the manufacturer who will send you your own special version of the program. You can make as many copies as you want or copy it to a hard disk; it doesn't matter since you can run the program on only that particular processor. Of course, if you use more than one computer (one at home, one at the office) or if several computers share a single disk, there is still a problem, but software vendors will probably have a more liberal policy for multiple copies.

While each processor will probably cost a little more, the decline in software prices should easily make up for that. Nor should the encryption affect the speed, since the decryption can be done in parallel with the execution of previous instructions. Since the decryption key is locked inside the processor, it would be almost impossible to decrypt the program. As a programmer and a user, I'm looking forward to the day of secure (and affordable) software.

KENNY HIRSCH
Chapel Hill, NC

Over my dead body! Next they'll want us to have our social security number permanently stamped into any copy of a book we buy, and severe penalties for reading someone else's book . . .

The decline in software prices will be enough; we don't need schemes like this! —Jerry ■

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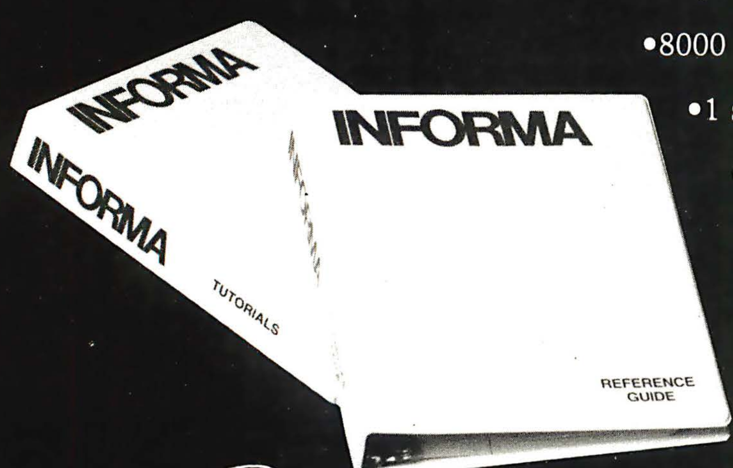
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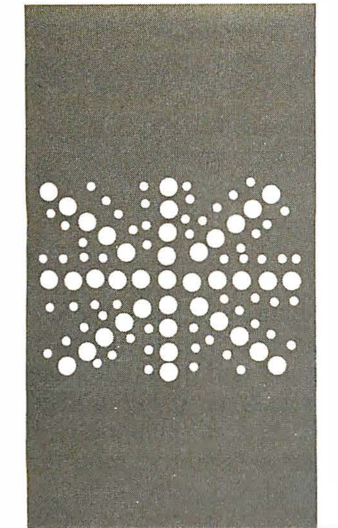
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B·Y·T·E U.K.

The Amstrad CPC 464

The home computer in the U.K.

BY DICK POUNTAIN

It's not easy for a U.K. citizen to write about home computers for an American magazine. We use the term to refer to an altogether different object on our side of the Atlantic.

In the U.S.A., an Apple II is a home computer; the IBM PC in its smaller configurations is a home computer; the Macintosh is a home computer. Home computers use floppy disks for mass storage and perform useful functions like word processing and income tax preparation as well as playing games.

In the U.K., those computers would be considered rather expensive as business computers, let alone for home use. Home computers here typically cost less than £200 (about $250) and use cassette tape recorders for mass storage. We have various manufacturers of our own, some unheard of in the U.S.A.—Sinclair Spectrum, Acorn Electron, Oric Atmos, Memotech, Enterprise, and Amstrad. Others, like Newbrain, Jupiter, Lynx, and Dragon, are already defunct. Even when we do have machines in common (the Commodore 64), I suspect that the vast majority of U.S. users buy the disk drive, while the majority of U.K. users have only the cassette deck.

A philosophical question that our Sunday newspapers love to debate (once a month on average) is: what are home computers for? The truthful answer (though seldom the one given) is: to play with. The vast majority of home computers are used solely for playing games or learning programming. Until disk drives become the norm rather than the exception, that will remain the case.

The fact that "home computer" has an essentially different meaning in our respective cultures is clearly demonstrated by the relative lack of success of those British models marketed in the U.S.A. (e.g., the Timex Sinclair 2068). With higher spending power and expectations than their British equivalents, U.S. buyers aren't tempted (and might even be repelled) by ultralow prices.

I'm devoting this month's column to a recent British home computer that promises to be more useful than most. My criteria for usefulness include a robust typewriter keyboard, the ability to display the standard 80-column by 24-character text screen (most go up to only 40 columns), a disk-drive option of reasonable capacity and cost, and support for a mainstream operating system such as CP/M or MS-DOS. Only then could I recommend a home computer as a dual-purpose business and pleasure purchase. The Amstrad computer comes the closest yet to filling this bill.

AMSTRAD CPC 464

The name Amstrad is associated with budget hi-fi in Britain. The firm, part of the giant GEC group, has beaten the Japanese at their own game and captured a lion's share of our home market for low-priced racked systems.

In June 1984, Amstrad entered the home computer market with a machine bearing the unsexy title CPC 464. It was designed wholly in Britain in conjunction with Locomotive Software, a seasoned Z80 systems house. Locomotive produced a neat operating system for the CPC 464; it incorporates so many good ideas that I wish it had emerged four years ago when the Z80 was still hot.

The CPC 464 is based around a 4-MHz Z80A with a full 64K bytes of RAM (random-access read/write memory) and a paged ROM (read-only memory) system of fiendish ingenuity. The computer package is noteworthy for consumer-oriented features that have accrued from Amstrad's hi-fi experience. It's a "ready to go" system, incorporating both a video-display unit (VDU) and a cassette recorder in the basic package. Two models are available, with either a monochrome or RGB (red-green-blue) color monitor, for £200 or £300 (about $250 or $375), respectively. Most color monitors cost £300 here, *without* a computer.

(continued)

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, POB 372, *Hancock*, NH 03449.

The color monitor uses a modified Amstrad television tube and the bandwidth is barely adequate for the computer's 80-column text mode, though it gives good saturated color and a steady display. The green-screen monochrome monitor is fine for 80-column work.

A power supply, which is incorporated into both monitors, drives the computer console, so only a single power cord is necessary for the whole system. The console is the size of an IBM keyboard unit (though deeper) and has a cassette recorder built in at the right end. This unit is not fully software-operated though; like the old PET, you must switch the Play, Record, and Rewind buttons by hand. The keyboard is the best I've found on a home computer and quite adequate for word processing. It has a huge Enter key, a separate numeric pad, and a compass-style cursor group; the keys are brightly color-coded.

Sound and color are strongly featured. The CPC 464 has a total of 27 colors, from which a palette of 16, 4, or 2 must be selected according to screen mode. The GI AY-3-8912 chip provides sound; it supports three voices (in stereo), with both tone and volume envelopes. The operating system allows sophisticated concurrent manipulation of sounds using queues and rendezvous. While this chip lacks the filters and ring modulators of Commodore's sound interface device (SID), you can easily exploit its capabilities through BASIC; I certainly can't say that about the Commodore 64.

As for the CPC 464's other silicon content, a 6845 controls the CRT (cathode-ray tube) display while an 8255 parallel peripheral interface controls the cassette recorder and the built-in Centronics printer port. A single Ferranti custom gate array does everything else. Since the memory is in the form of a mere eight 64K-byte chips, the circuit board resembles an underpopulated suburb rather than the usual city center.

The most obvious hardware omission is a serial port; Amstrad will offer one later but only as an add-on.

BASIC

The most interesting features of the CPC 464 are Locomotive's BASIC and the operating system. The BASIC is largely standard Microsoft version 5.X with extensions for graphics, sound, multitasking, and interrupts, and a clean implementation of streamed I/O (input/output). It ran the Sieve of Eratosthenes in 1324 seconds, faster than a grown-up CP/M machine running MS-BASIC.

A SOUND command that takes seven parameters supports sound. Envelopes are declared like arrays with the ENV (volume) and ENT


(continued)

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(tone) keywords. You can declare any number of envelopes because only the envelope number is passed to SOUND, which means you can swap envelopes easily.

The graphics commands are unsophisticated by today's standards: only point and line drawing, with no fill or circle draw routines. Amstrad will release an extended graphics set as a ROM expansion.

The multitasking and interrupt facilities use a nice natural syntax, similar to the American National Standards Institute (ANSI) BASIC real-time extensions. Four independent interval timers are provided, prioritized in the order 3, 2, 1, 0. A task is set in motion by calling its subroutine with either EVERY (repeat at stated intervals) or AFTER (delay for stated period) and a timer number. Such a subroutine then interrupts the main program at the specified times. The time units for specifying intervals are 1/300th-second timer ticks, which allows some pretty fine-grained interleaving of tasks. I used listing 1 to check this function.

Listing 1 uses interrupting routines on timers 0 and 1 and, at first, prints a string of c characters interspersed with an ab combination. As y increases and the b routine takes longer, the main program gets squeezed out (the c characters gradually disappear). Then the a routine is smothered, leaving only a string of bbbbbbbbbbbb. . . . If I change line 100 to give a the higher priority timer 2, then only aaaaaaaa . . . will survive this Darwinian struggle for processor time. This simple scheme of resource allocation ensures that you can't blow up the system and that something will always run (even if it isn't what you intend), an important feature in a system aimed at beginners.

When it's important that some program be allowed to terminate unmolested, you can disable software interrupts with the DI directive and reenable them later with EI. The operating system maintains a queue for all interrupt routines, although calls that overflow the queue will be lost. The REMAIN keyword returns the current count from any of the timers and resets it to zero.

I/O is handled by streams with an associated windowing capability. There are 10 streams recognized by the system, 0 to 7 for the screen, 8 for the printer, and 9 for the cassette. They don't have to be declared, opened, or closed, and stream 0 to the screen is the default. The WINDOW command links a stream with a screen window whose corner coordinates are optional arguments (whole screen is the default). Then PRINT and INPUT are simply redirected, by specifying the stream number, to the desired window. You can also create a high-resolution graphics window. These ideas aren't new, but the syntax feels cleaner and easier to use than previous attempts I've seen.

In short, the CPC 464's BASIC supports the available hardware to the extent that PEEK and POKE become redundant (though people will use them just the same).

Operating System

The CPC 464's operating system (OS) and architecture are neat. The OS sits in 16K-byte ROM at the bottom of memory while BASIC is in a 16K-byte ROM at the top of memory. Both

Listing 1: *Program to check out interrupt timing on the* CPC 464.

```
100 EVERY 10,0 GOSUB 1000
200 EVERY 10,1 GOSUB 2000
300 PRINT "c";:GOTO 300
1000 FOR x=1 TO 100: NEXT x:PRINT "a";:y=y+1
1100 RETURN
2000 FOR x=1 TO y :NEXT x :PRINT "b";
2100 RETURN
```

ROMs overlap the 64K bytes of RAM, the upper one overlapping screen memory. They are switched in and out in a most ingenious fashion. Locomotive Software uses five of the Z80 RESTART instructions to effectively extend the processor's instruction set, so that programs bring ROMs into the address space in a way that's transparent to the user. In particular the RST pseudo-instructions guarantee that a write operation always accesses RAM regardless of the ROM switch state. If an operating-system routine is called, the lower ROM will be switched in; the operating system switches out the upper ROM if it needs to access the screen. All operating-system routines restore the previous ROM state when they return. This scheme leaves you with a total of 43,533 bytes free for BASIC programs, which is at least 10K bytes more than on comparable machines.

Furthermore, you can place up to 252 extra 16K-byte ROMs into the upper ROM area, bank-switched via an I/O port and a unique ROM address. Expansion ROMs can be one of two types: background or foreground. BASIC is a foreground program that could be replaced by another, such as FORTH or CP/M. Whichever program is installed at ROM address 0 will take over the machine at boot-up—you don't need to physically replace the on-board ROM.

Background ROMs provide services to the current operating system, such as device drivers for new peripherals or extensions to the graphics routines. Only seven background ROMs can be installed. The operating-system kernel supports a kind of far addressing (a branch via I/O mapping to any one of 252 parallel ROMs in the upper ROM area) that lets a program call subroutines in ROM. In addition, ROM routines can call subroutines in other ROMs. Resident system extensions (RSXs) behave like background ROMs but must be loaded into memory—they are similar to MS-DOS version 2 configurable device drivers. For some applications that don't justify the cost of blowing a ROM, an RSX might be more suitable.

The operating-system software is written in a highly modular fashion. Separate units (called packs) deal with the keyboard, text VDU, graphics VDU, cassette, and sound, while a kernel handles interrupts, events, and the ROM selection mechanism. All OS calls are vectored through a RAM-based jump table in proper fashion, so programs can be insulated against future firmware changes.

The Keyboard Manager pack completely defines the interface to the keyboard hardware, so that a program

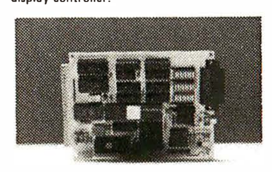
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- Up to 64K bytes of system ROM/EPROM.
- 2 RS-232C Serial & 3 Parallel I/O ports.
- Disk controller for 5¼" or 8" drives.
- Sixteen levels of vectored interrupts.

MPX-16 Circuit Board Assembled w/64K RAM .... $1,200.
OEM 100 quantity price .... 840.
MPX-16 Circuit Board Assembled w/256K RAM .... 1,400.
MPX-16 Semi-Kit (wave soldered circuit board w/all components) Less ICs .... 595.
Complete Kit of ICs w/256K RAM .... 595.
MPX-16 Unpopulated (bare) PC Board .... 300.
CP/M-86 Operating System + Manuals ..... 80.
MPX-16 Switching Power Supply .... 300.
MPX-16 Technical Reference Manual ...... 50.
MPX-16 Metal Enclosure with Fan .... 225.
Tandon TM 100-2 Double Sided/Density Drive .... 300.
IBM/PC Keyboard Interface Adapter ..... 100.

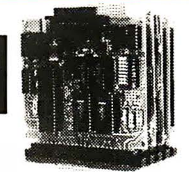
Shipping and handling additional on MPX-16 orders.

IBM PC is a trademark of International Business Machines Inc.
CP/M-86 is a trademark of Digital Research Inc.
Z8 is a trademark of Zilog Inc.

Inquiry 234

Z8 COMPUTER SYSTEM

BASIC System Controller



The Z8 Basic System Controller is an updated version of our popular BCC01. The price has been reduced and features added. The entire computer is 4" by 4¼" and includes a tiny BASIC interpreter, up to 6K bytes of RAM and EPROM, one RS-232C serial port with switchable baud rates and two parallel ports. BASIC or machine language programming is accomplished simply by connecting a CRT terminal. Programs can be transferred to 2732 EPROMs with an optional EPROM programmer for auto start applications. Additional Z8 peripheral boards include memory expansion, serial and parallel I/O, real time clock, an A/D Converter and an EPROM programmer.
- Uses Zilog Z8 single chip microprocessor.
- Data and address buses available for complete peripheral expansion
- Can be battery operated.
- Cross assemblers for various computers.

BCC11 Assembled & Tested .... $149. New Low Price

FORTH Language Version

With the new Z8 with on board 4K FORTH you can program high speed control functions in a few simple high level language commands. Perfect for data reduction, process control and high speed control applications.
BCC20 Z8F FORTH Microprocessor chip . $150.
BCC21 Z8F FORTH System Controller (This board is a BCC11 with a BCC20 installed) Assembled & Tested .... 280.

Memory, I/O Expansion, Cassette Interface

- 8K bytes of additional RAM or EPROM.
- Three additional 8 bit parallel ports.
- Cassette interface – 300 baud K.C. Standard.
- Software real time clock.

BCC33 w/0K RAM Assembled & Tested ... $150.
BCC34 w/6K RAM Assembled & Tested ... $180.

Eprom Programmer

- Transfer BASIC or Assembly Language application programs from RAM to 2716 or 2732 EPROM.
- Comes with programming & utility routines on EPROM.
- Requires Z8 I/O Expansion Board for operation.

BCC07 Assembled & Tested .... $145.

Analog to Digital Converter

- Uses Analog Devices 7581 IC, 8-channel 8-bit.
- Adds process control capability to the Z8 system
- Over 1,000 conversions per channel per second.
- Monitors 8 analog signals in one of two 10v Ranges.

BCC13 Assembled & Tested .... $140.

Serial Expansion Board

- Adds additional RS-232C and opto-isolated 20 ma. current loop serial port to the Z8 System.
- Runs at 75 to 19,200 baud in all protocols.
- Comes with listings of sample serial I/O routines.

BCC08 Assembled & Tested .... $160.

16K Memory Expansion Board

- Add up to 16K of additional memory, RAM or EPROM, to your Z8 System Controller in any multiple.
- Accepts 2016, 6116, 2716, or 2732 memory types.
- Four 16K cards may be installed on the Z8 System bringing the total memory to 64K.

BCC14 Assembled & Tested w/4K RAM . $120.

Cross Assemblers

From Micro Resources
IBM PC, APPLE, 6502 Systems 5¼", CP/M 2.2 8" .... $75.
From Allen Ashley
TRS-80 Model I, III, Northstar 5¼" .... 75.
CP/M 2.2 8" .... 150.

Five Slot Mother Board

- Expand your Z8 BASIC System with minimum effort.
- Contains five slots complete w/44 pin connectors.

MB02 Assembled & Tested .... $69.

Triple Voltage Power Supplies

+5V @ 300 ma. +/- 12V @ 25 ma.
UPS01 Assembled & Tested .... $35.
UPS02 Complete Kit .... 27.
+5V @ 1 Amp. +12V @ .5 Amp. -12V @ 50 ma.
UPS03 Assembled & Tested .... 60.
UPS04 Complete Kit .... 50.

SPEECH PRODUCTS

Lis' ner 1000 Voice Recognition Board



Uses the new, high performance SP1000 voice recognition chip.

The LIS' NER 1000 provides voice input capability for your computer. The unit functions in the same manner as your keyboard, serving as a data entry device for application programs or the normal operation of the computer.

The LIS' NER 1000 recognition system works by analyzing human speech and extracting the most important features. These impressions of words are compacted into "templates" which can be stored and later compared to someone talking to the recognition unit. The LIS' NER 1000 supports a 64 word vocabulary in speaker dependent, discrete utterance mode. The recognition accuracy is greater than 98%. Each unit comes with a professional quality headband style electret microphone to assure accuracy, software on diskette and a user's manual.

The APPLE II LIS' NER board has provision for an SSI 263 phonetic speech synthesizer chip with text-to-speech algorithm, This addition provides all the features described for the Sweet Talker II as well as speech recognition.

APPLE II LIS' NER 1000 with SP1000 recognition/synthesis components only
VR01 Assembled & Tested .... $189.
VR02 Complete Kit .... $149.
APPLE II LIS' NER 1000 with SP1000 recognition/synthesis components and SSI 263 phoneme synthesizer chip with text to speech algorithm.
VR03 Assembled and Tested .... $259.
VR04 Complete Kit .... $219.
COMMODORE 64 LIS' NER 1000 with SP1000 recognition/synthesis components
VR10 Assembled & Tested .... $149.
VR11 Complete Kit .... $119.

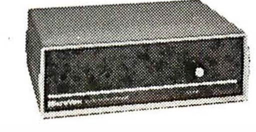
Sweet Talker II Text-to-Speech Synthesizer



SWEET TALKER II, a 3rd generation speech synthesizer, is based on the SSI 263. SWEET TALKER II directly drives a speaker to provide music, sound effects and continuous speech of unlimited vocabulary at data rates as low as 50-70 bps.
- SSI 263-based Apple II compatible speech speech synthesis board
- Comes with text-to-speech algorithm on disk (DOS 3.3)
- Appropriate control inputs for mapping with several buses
- On-board 1 watt amplifier with volume control
- Measures 3" x 3¼"
- Operates on +5 and +12v

ST22 SWEET TALKER II Apple II compatible speech synthesizer with text-to-speech algorithm on disk .... $104.

Microvox Text-to-Speech Synthesizer



Microvox is a professional voice quality text- to speech synthesizer that is easily interfaced to any computer, modem, RS-232C serial or parallel output device and provides speech of unbelievable clarity.
- Unlimited vocabulary.
- 64 programmable inflection levels.
- 6K text-to-speech algorithm.
- Full ASCII character set recognition and echo.
- RS232C and parallel input.
- 1000 Character buffer, 3000 optional.
- Adjustable baud rates (75-9600).
- Spelling output mode.
- 7 octave music and sound effects.
- On board audio amplifier & power supply.
- X-On/X-Off handshaking.

MV01 Assembled with 1K buffer .... $349.
MV02 Complete Kit with 1K buffer ..... $269.
Add $15.00 for 3K buffer option.

Speech Synthesizer IC's

The SC-01A Speech Synthesizer is a completely self-contained solid state device that phonetically synthesizes continuous speech of unlimited vocabulary.
SC01A Quantity 1-99 .... $32.
100+ .... $24.
1000+ .... call

The Silicon Systems SSI 263 Speech Synthesizer Chip is a third generation speech synthesizer chip that produces even more intelligible speech than did older devices. The SSI 263 has improved intonation, inflection and filtration.
SSI 263 Quantity 1-9 .... $42. ea.
10-99 .... $34. ea.
100 .... $30. ea.

The Micromint is stocking thousands of SP1000 voice recognition chips. Call us for a quote.

MICRO D-CAM DIGITAL TV CAMERA



Give your computer the dimension of sight.
- Interprets, enhances and stores images.
- 256 x 128 digital image sensor.
- Plug-in boards for the IBM-PC, APPLE II or e.
- Software includes utilities for auto exposure. multi-level greyscale, screen dump and image enhancement.
- Includes interface card, 4 foot extension cable camera assembly, manual, and software on diskette.

DC01 IBM PC Assembled & Tested ...... $299.
DC02 IBM PC Complete Kit .... $264.
DC03 APPLE II Assembled & Tested .... $299.
DC04 APPLE II Complete Kit .... $264.

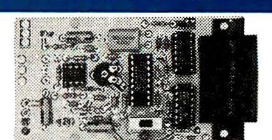
ULTRASONIC RANGING SYSTEM

The Micromint Sonar Ranging Experimenter's Kit is an updated and higher functioning version of the Polaroid SX-70 Camera sonar ranging circuit used in the original Polaroid Ultrasonic Ranging System Designer's Kit. There are similar performance characteristics but this unit requires far less support circuitry and interface hardware.

The TI ranging module can function between 4.5 and 6.8v. With a 5v supply, the ranging module I/O is TTL compatible and can be connected directly to most computers with one input and one output bit.

The Sonar Ranging Experimenter's Kit includes one SN28827 ranging module, one Polaroid 50 KHz electrostatic transducer, and user's manual with data sheets.
TI01 Sonar Ranging Experimenters Kit... $60.

300 BAUD ANSWER/ ORIGINATE MODEM KIT



Micromint's latest 300 Baud Modem Kit is crystal controlled, uses the TI TMS99532 IC, contains just 25 parts and requires no calibration or adjustments. Use with acoustic coupler or in direct connect mode.
MD04 Complete Kit as shown .... $60.
MD05 Transformer for Direct Connect Mode $9.
AC01 Acoustic Coupler Kit .... $20.

***MICROMINT INC.** 561 Willow Avenue, Cedarhurst, NY 11516*
***To Order:** Call Toll Free 1-800-645-3479*
***For Information Call:** 1-516-374-6793*
Call: Monday-Friday, 9-5 PM



can alter attributes such as which keys repeat and their repeat speed. Joysticks are scanned as part of the keyboard. You can program up to 32 keys (except Escape) to produce user-defined strings or to generate any of the 255 (full 8-bit) characters. The Escape key is given special treatment; pressing it once suspends execution and a second Escape causes a breakout from the program, while any other keypress resumes execution. This global-friendly behavior should be a function of all operating systems, but usually it's left to individual applications and so is inconsistent.

The VDU is handled by two packs for text and graphics, which are coordinated by a third layer, the Screen Manager. All screen output on the CPC 464 is fully bit-mapped (maximum resolution: 640 by 200 pixels). Text and pixel graphics use the same 16K-byte buffer. The standard character matrixes are stored in ROM but the user can, as on the Commodore 64, download them into RAM and redefine them.

A special mode of character output called "transparent print" permits superimposing a character shape on the current screen contents (i.e., the cell background is transparent), so graphics can be annotated with text without making holes in the lines.

The CPC 464 supports three screen modes corresponding to 20, 40, and 80 columns, and the graphics pack is cleverly designed so that the plotting coordinates remain the same in all modes. A picture will remain the same size but will have coarser lines as the modes change. The cost of this scheme is that the screen memory map has a nasty, interleaved structure that complicates attempts to bypass the operating system and poke straight into it. On the other hand, the OS offers four graphics write modes (replace, and, or, xor) that allow a combination of the new pixel color with the current color so you can have tricky bit-plane effects if you stay legal.

The Sound Manager is complicated; suffice it to say that it maintains a separate sound queue for each of the three channels, and these are processed concurrently. When a tune requires synchronization, you can force a rendezvous between any or all of the queues. You can also cause a channel to hold until explicitly released.

The kernel is based around an event handler that is driven by a regular timer interrupt synchronized to the VDU frame flyback. Elapsed-time measurement for the BASIC multitasking is provided by a separate counter that counts these timer interrupts and

(continued)



The CPC 464 was designed to be used for serious work as well as for game playing.

then triggers an event. This avoids the heavy overhead of triggering a timer event every tick.

All the foregoing is documented in an impressive programmers technical manual that is clear, intelligent, and comprehensive (more so than those for many supposedly professional operating systems).

CP/M

As I write this column, Amstrad is a few weeks from releasing a disk drive for the CPC 464 based on the Hitachi 3-inch floppy disk, giving 180K bytes per side in "flip-over" two-sided operation. Two drives can be supported by the same interface and cable. At £199.95, the drive is cheaper than the notorious Commodore 1541.

Amstrad will supply CP/M free with the drive. A foreground ROM in the drive contains a special BIOS (basic input/output system) that actually works through the Amstrad OS ROM routines. When you boot a disk, the BDOS (basic disk operating system) and CCP (console command processor) will load into memory from disk as usual. You can also use the disk from Amstrad BASIC via a stream, and the file format will be the same as CP/M's to avoid introducing two different disk formats.

Although the CPC 464 will be the cheapest CP/M system available by a comfortable margin (just £400 or about $500 for a single-disk, monochrome system), it has limitations. CP/M was not designed to cope with the memory-mapped video of typical home computers, but for systems with a serial terminal. Because the CPC 464 has its screen buffer fixed in the upper 16K bytes of memory, it can support only a 43.5K-byte CP/M system, which leaves a transient program area (TPA) of some 36K bytes. Some CP/M software (including standard WordStar) needs more space. However, since 48K-byte CP/M systems were quite common until recently, a lot of older packages should work.

Overview

The technical problem posed to designers of low-cost home computers is: how can you support the color graphics, complex sound capabilities, acceptable speed, and adequate working store that the market demands, by using a cheap 8-bit processor with only a 64K-byte address space? The most obvious solution is not to try, but to use a 16-bit processor. The prices of 16-bit components and the relative lack of design and programming experience for them have delayed this natural step, although the picture will change drastically if Commodore drops the launch price of the Amiga to the rumored level.

The Amstrad approach might be the best compromise I've seen so far, providing fast (for an interpreter) and usable BASIC with more than average free workspace. The ROM paging system allows virtually unlimited expansion or reconfiguration of the firmware. Its closest competitors are the Commodore 64 and the proposed machines based on Microsoft's MSX standard. The operating firmware and BASIC are better thought out than the ad hoc jumble supplied by Commodore, while MSX is likely to be slower and offer less free workspace. On the other hand, both competitors offer sprites, and MSX has more powerful graphics commands (including a graphics macro language). The Amstrad compromise allows for the possibility that the CPC 464 will be used for serious work as well as game playing, although time will tell whether the marketplace agrees.

Heeding the dismal experiences of other U.K. manufacturers, Amstrad has no plans at present to launch the CPC 464 in the U.S.A. ■

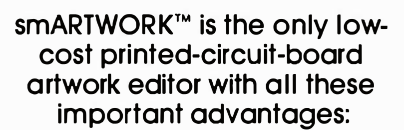
Circuit-Board-Design Without the Tedium

smARTWORK™ lets the design engineer create and revise printed-circuit-board artwork on the IBM Personal Computer.

Forget tape. Forget ruling. Forget waiting for a technician, draftsman, or the CAD department to get to your project. smARTWORK™ software turns your IBM Personal Computer into a professional, high-quality drafting tool. It gives you complete control over your circuit-board artwork — from start to finish.

smARTWORK™ transforms your IBM PC into a CAD system for printed-circuit-board artwork. Display modes include both single-layer black and white and dual-la er color.

What makes smARTWORK™ so smart is that it understands electrical connections. Conductor spacing is always correct, lines don't become too narrow, and connecting lines do not intersect other conductors. smARTWORK™ can automatically find and draw the shortest route between two conductors. Or you can specify the route.

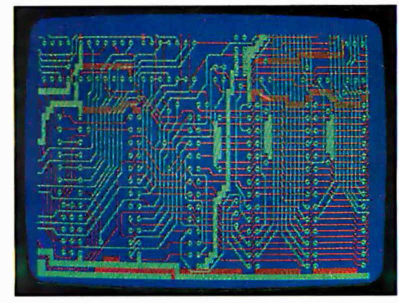


smARTWORK™ is the only low-cost printed-circuit-board artwork editor with all these important advantages:

- ☐ Complete interactive control over placement and routing
- ☐ Quick correction and revision
- ☐ Production-quality 2X artwork from pen-and-ink plotter
- ☐ Prototype-quality 2X artwork from dot-matrix printer
- ☐ Easy to learn and operate, yet capable of sophisticated layouts
- ☐ Single-sided and double-sided printed-circuit boards up to 10 x 16 inches
- ☐ Multicolor or black-and-white display
- ☐ 32 user selectable color combinations; coincident points can be displayed in contrasting colors.
- ☐ Can use optional Microsoft Mouse as pointing device



Twice scale hardcopy of your artwork is produced using the Epson dot-matrix printers or the Houston Instrument DMP-41 pen-and-ink plotter. Quick 1X check plot is also available from Epson printers.



Dual-layer color display of a 2" by 4" section of a 10" by 16" circuit board

The Smart Buy

At $895, smARTWORK™ is an exceptional value, particularly when compared to conventional engineering workstation costs.

Call or write us for more information on smARTWORK.™ We'll be glad to tell you how smARTWORK™ helps us design our own circuit boards and what it can do for your business.

Send a purchase order, or major credit card number, and smARTWORK™ can be working for you next week.

System Requirements

- ☐ IBM PC or XT with 192K RAM, 2 disk drives and DOS Version 2.0
- ☐ IBM Color/Graphics Adapter with RGB color or b&w monitor
- ☐ Epson MX-80/MX-100 or FX-80/FX-100 dot-matrix printer
- ☐ Houston Instrument DMP-41 pen-and-ink plotter (optional)
- ☐ Microsoft Mouse (optional)



WINTEK CORPORATION, 1801 South St., Lafayette, IN 47904-2993, Phone: (317) 742-8428, Telex: 70-9079 (WINTEK CORP UD)

INTRODUCING
Interface Technologies' Modula-2 Software Development System

The computer press is hailing Modula-2 as "the next standard in programming languages." Modula-2 combines the strengths of Pascal with the features that made C so popular, like independent compilation and direct hardware control.

But until today, no company offered a Modula-2 system that made the development of software fast, easy and efficient. Now, though, there's a new tool at your disposal.

The fast, powerful tool for programmers

The breakthrough is here: Interface Technologies' new Modula-2 Software Development System for the IBM® PC, XT, AT and compatible computers to give programmers the same quantum leap in productivity spreadsheets and word processors gave to end-users. It can reduce monotonous wait time, will dramatically increase speed, help stop thoughtless mistakes, and free you to become more creative in virtually all of your programming efforts.

How to speed input and eliminate 30% of errors

Thirty percent of programming mistakes are syntax errors and simple typos in the program structure. Our "syntax-directed" Modula-2 editor does away with these time-consuming headaches once and for all.

It speeds input by cutting manual typing as much as 90%, letting you enter statements with a single keystroke. For example, if you type a capital "I" to begin a line, the editor completes the logical "IF THEN" statement automatically, so you can concentrate on what you want to program, rather than concentrate on what you're typing.

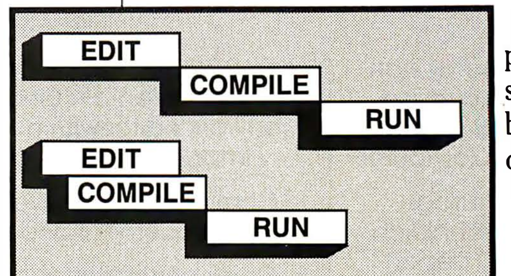
Enter complete statements with one keystroke.

The editor locks out errors, finishing statements and procedures in perfect accord with the standardized rules of Modula-2. It also indents and formats your text automatically, making programs easy to read and maintain, an important feature on big projects.

And if you leave an undefined variable or data type, the editor detects the mistake and gives you the option of on-line "help" to correct it. No other programming text editor offers you so much innovation at any price.

How to turn "wait time" into "work time"

The vast majority of programming time is spent waiting, and the biggest slowdown is most often with compilers.



It not only has a faster compiler, it also saves time by compiling while you edit.

THE ANATOMY OF A

Our compiler turns wait time to work time with a new innovation that lets you compile in the "background."

With background compilation, your program is automatically compiled into object code line by line as you work, every minute you spend writing or editing a Modula-2 program!

When you're finished editing, all that's left for the compiler is a quick mopping up job that generates optimized native code in a single pass.

How quick is "quick"?

Thanks to background compilation and the fact that the compiler itself is so fast, Interface Technologies' compiler turns 100 lines of typical Modula-2 text into optimized machine code in *under five seconds.*

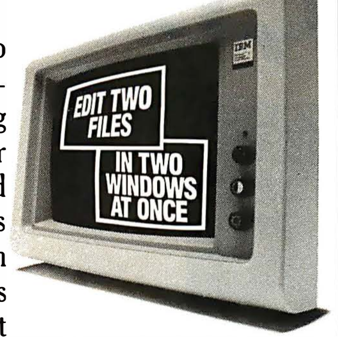
Plus the Interface compiler produces compact code with execution speed superior to that produced by any other Modula-2 compiler on the market.

How to do two things at once

Along with the background compiler and syntax-directed editor, which can save you hours every day and make you more productive, Interface Technologies' Software Development System gives your monitor

windows so you can refer to one file while you edit another simultaneously, saving you even more time.

Concurrent editing of two or more files is especially useful when doing programming work that's intended for separate compilation, and Interface Technologies has the only Modula-2 system on the market that provides you with this helpful benefit for developing software.



Work with multiple files faster, easier in windows.

How preprogrammed modules speed development

One of the advantages of Modula-2 is that it lets you build large, reliable programs quickly, by linking together many smaller "building-block" modules.

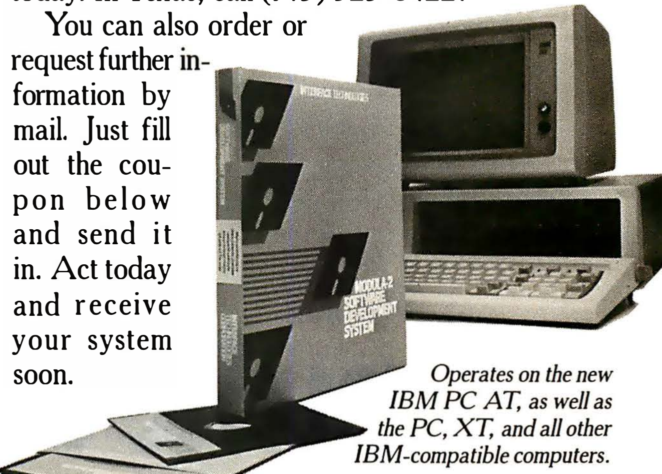
The development system's toolkit of precompiled program modules includes the standard Modula-2 library, and adds exclusive link-and-run modules for direct calls to the operating system, sound, and color

You can use it on any IBM® PC, XT, AT or compatible computer with two double-sided, double-density floppy drives and 320K RAM diskette.

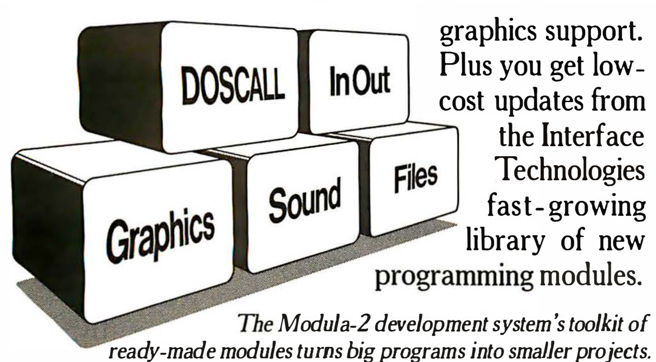
You get a thoroughly indexed, comprehensive user's manual and free telephone support from Interface Technologies. But the most important thing you get is the future, and *the programming language of the future is Modula-2,* and now it's easier than ever.

For more information, or to order the Modula-2 Software Development System, call 1-800-922-9049 today. In Texas, call (713) 523-8422.

You can also order or request further information by mail. Just fill out the coupon below and send it in. Act today and receive your system soon.


Operates on the new IBM PC AT, as well as the PC, XT, and all other IBM-compatible computers.

BREAKTHROUGH



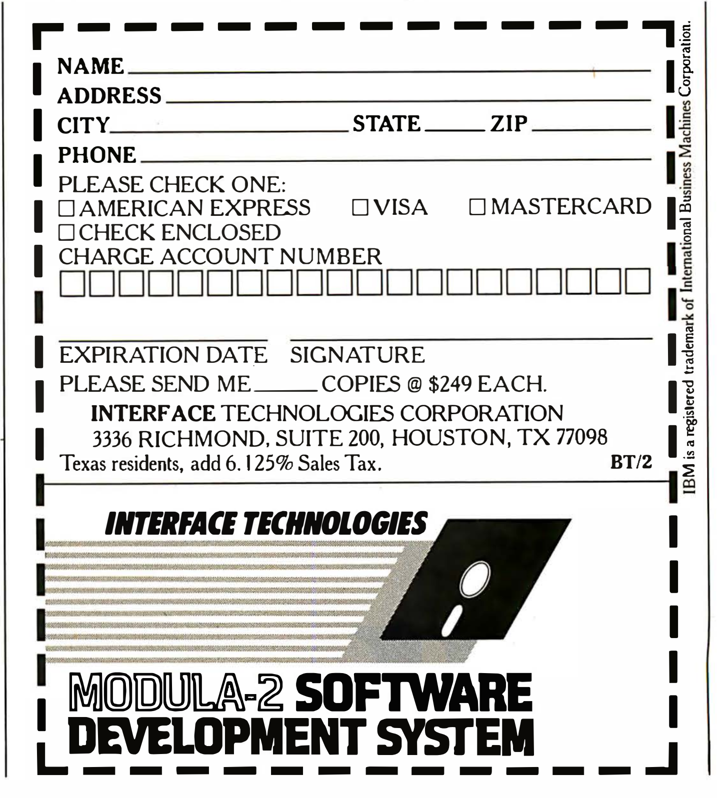
graphics support. Plus you get low-cost updates from the Interface Technologies fast-growing library of new programming modules.

The Modula-2 development system's toolkit of ready-made modules turns big programs into smaller projects.

Increase productivity for $249

Interface Technologies' Software Development System is fast, powerful and unlimited. It works so well that it's the same tool Interface Technologies is using to write business and consumer applications in Modula-2.

For $249, you get the syntax-directed editor and compiler, linker, module library and tutorial that will have even modestly experienced programmers writing in Modula-2 in days. And you have full rights to your work; there's no license fee for programs you develop with the Interface Technologies system.


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CITY ________ STATE ____ ZIP ____
PHONE ________
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☐ CHECK ENCLOSED
CHARGE ACCOUNT NUMBER
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This October, 1983 ad



pulled 2,391 sales leads. On page 489.

This is not an exception. In the same issue on page 409, WYSE Technology's ad generated 1,792 inquiries and the Prometheus ad – way back on page 495 – garnered 1,588.

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C·I·R·C·U·I·T C·E·L·L·A·R F·E·E·D·B·A·C·K

Conducted by Steve Ciarcia

More I/O

Dear Steve,

I would like to embark on my first hardware project by building a home-control system constructed around a Z80-based Heathkit H-89 CP/M computer. My problem is the I/O interface. My computer has only two available I/O slots. I need more, so I want to build a board that fits into the processor socket and runs all the signal lines into a ribbon cable that connects to new I/O slots. This board will also contain the processor IC. I will have to bypass the I/O-mapping ROM in the computer to enable the new I/O slots. What do you think, Steve?

Charles M. Fingerman
Toms River, NJ

My April article will address most of your questions on I/O for a home-security system. The system will use a microprocessor that sends its control signals through the power lines to various BSR modules but has closed-loop input and output lines in addition. While my unit is built around a Motorola 6800 microprocessor, the techniques and software should be applicable to your Z80 system.

You may want to consider my unit for your control applications and merely use your H-89 to remotely communicate with my home-control system. Tying up an entire Z80-based CP/M system for home control is a bit of overkill. A small, dedicated controller is more practical.—Steve

Term-Mite and Color Television

Dear Steve,

I want to build the Term-Mite smart terminal that you described in the January and February 1984 issues of BYTE. Can you tell me how to connect the composite video output of the Term-Mite to a color television?

Robert E. Scott
Lawrenceville, GA

The composite video output of the Term-Mite is similar to the composite output of any computer and will directly drive a video monitor. To drive a color or black-and-white television, this composite video signal must be superimposed on a radio-frequency signal so that the television can receive it. The device to do this, an RF modulator, is available at almost any computer or electronics store.

Simply connect the video output of the Term-Mite into the RF modulator, connect the modulator output to your television antenna terminals, and apply power to all units. Turn the channel selector to the channel for which the modulator is designed and adjust the fine-tuning control as required.—Steve

Simple Clock Not So Simple

Dear Steve,

In your May 1982 article you highlighted the then-new MM58167A clock chip and its companion, the MM58174A. I wired the MM58174A to my Apple II to use the chip as a simple clock. Though I did so exactly as shown in National Semiconductor's data sheet, one problem has always remained: the interrupt output refuses to work as it's supposed to. I followed the interrupt-setting procedure but could get no more than a single immediate pulse or a change of state. As you may know, the interrupt is supposed to be programmable for three different intervals, single or repeated. Do you have any idea what I can do to resolve the problem?

Lance Walley
Carmichael, CA

A rather subtle problem exists with the MM58174A real-time-clock chip. It is relatively slow when compared to a typical microprocessor clock cycle, with access times on the order of 1 microsecond. An interrupt pin is available to introduce wait states for the read and write cycles of the microprocessor to offset this timing difference. This is fine for an 8080 system that supports such wait states but cannot be directly implemented on your Apple II since the Ready input of the 6502 is available only during a read cycle.

One solution would be to drive the MM58174A chip through a PIA or VIA chip such as a 6520 or 6522. One port can be used to latch the address of the desired clock registers, and the other used to write data on a subsequent cycle.
—Steve

Trump Card Harmony

Dear Steve,

Will the Trump Card (May and June 1984) memory interface with other cards in the computer? Also, can I use it as RAM in addition to other RAM boards in the system?

Chip O'Neal
Orlando, FL

The Trump Card memory is totally independent of the memory in the host computer and does not take up any space in the host memory map. The other memory boards in the system will operate the same as they did before the Trump Card was installed. The memory on the Trump Card can be used as an independent spooler and RAM disk for the host system when not being used to run any of the Trump Card languages. In this mode, the Trump Card memory acts like an extra 512K bytes of memory added to your system.—Steve

A Mistake?

Dear Steve,

I really enjoyed your BYTE articles on the Trump Card, and I intend to implement it in part or whole some day. I may not fully understand the circuit, but there are a couple of anomalies I want to ask about and some ideas that I would like to hear your reaction to.

The $\overline{\text{INH}}$ line of the Z8581 clock IC is tied to ground on the Trump Card circuit. The Z8581 data sheet indicates that this should make the $\overline{\text{ADD1}}$ and $\overline{\text{ADD2}}$ lines inactive. Yet, you have logic feeding $\overline{\text{ADD2}}$. Is something drawn wrong, or am I misinterpreting something?

The 6116 buffer is normally a 2K by 8-bit RAM, but the Trump Card appears to use only 256 bytes of it, since only eight of the address lines are fed from the counters. I suppose that's enough, but it

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seems a waste. Would there be any advantage to adding another 74LS393 or similar (maybe single 4-bit) counter to supply the other three address lines? I realize the software on both sides would have to be changed to make use of the larger buffer size.

Your software and documentation offer sounds almost too good to be true. Is the host (IBM PC) software locked into the IBM or the 8088? The reason I ask is that I would really like to implement a Trump Card and use the software package you are offering, but my present system is a Heath H-8 with an 8080 processor. I may someday change to a Z80, but I don't expect to go to an 8088. I can't justify an 8088-based system, IBM or otherwise, since my current system does what I need as it is.

So why implement the Trump Card? I guess I've got solder in my blood and a hacker's spirit of adventure. (I also prefer programming in solder and wire.) Anyway, since I do my software hacking in C (mostly) or assembly language, I don't see any problem making the Trump Card work with my 8-bit CP/M system, assuming that the source for the host code is available (hopefully, part of your offer). As a matter of fact, I like C so much that the C compiler part of your software offer is the most important part to me. The Z80 emulator sounds interesting, though. Does it emulate any specific operating-system calls (BDOS or BIOS), or does the application software have to know that it's talking to another processor through the FIFO buffer? If I can plug a Trump Card into my CP/M-80 system, I won't have to even consider getting an 8088 or other 16-bit processor, will I? With TBASIC and Z8000 C, and Pascal on the way, what more could I want?

DWAIN HENDERSON
Florida, NY

Yes, something is wrong! The four pins on the Z8581 clock chip numbered 4, 8, 9, and 10 are mislabeled but wired correctly. They should be labeled as follows:

Pin 4	*$\overline{INH}$*	*HI*
Pin 8	*CO*	*N/C*
Pin 9	*CI*	*N/C*
Pin 10	*$\overline{STRT}$*	*LOW*

This arrangement allows ZCLK to be stretched by one period when $\overline{ADDR2}$ is low to account for the slower PROM memory.

Again, you are correct about the Trump Card using only the first 256 bytes of the 2K-byte 6116 buffer. A smaller static RAM could have been used in this case, but the low cost and availability of the byte-wide 6116 outweigh any advantage of using the smaller RAM. There is no advantage in board space with the smaller RAM since the available 256-byte RAM chips are 4 bits wide, and two chips would have been required for the buffer.

You can add an additional 74LS393 and use more of the 6116, but since much of the I/O between the Z8001 and the 8088 consists of short commands, this would only add an additional delay in these operations.

Your ideas about using the Trump Card with another host processor can be implemented, but the object code for LDSYS would have to be modified to accommodate your new host. Unfortunately, at the moment the source code for the LDSYS program is not part of the available software package.

The Z80 emulator supports most of the standard CP/M BIOS calls, except for calls dealing with the disk, the punch, and the reader. The calls that are supported by the emulator are listed in the software manual for the Trump Card.—Steve

SPEECH CHIPS

Dear Steve,

After reading your article "Use ADPCM for Highly Intelligible Speech Synthesis" in the June 1983 BYTE, I became interested in building the circuit you described. Since I am not familiar with the ICs used, I would appreciate it if you can send me more information concerning the design of this circuit. I would also like to know if there have been any new developments in this area of waveform speech synthesis. Finally, are there possible variations on the circuit built around the Oki MSM5218?

JOE LEE
New York, NY

The chips used in that article are manufactured by Oki Semiconductor, 1333 Lawrence Expressway, Suite 401, Santa Clara, CA 95051, (408) 984-4842.

Oki has several technical data sheets that give additional information and applications. Two of them are "Simultaneous Speech Analysis and Synthesis with the OKI MSM5218" and "Speech Synthesis using the OKI MSM5205 ADPCM Speech Synthesizer Circuit."

The information in my article and the additional data from Oki should give you the background you need to build your own speech circuits. If you are unfamiliar with such circuits, build the one described in my article first. After you understand how it functions, you can adapt your own variations.—Steve

DO I HAVE CIRCUITS?

Dear Steve,

Your July 1984 article about the Whimsi-Bell contained information and circuits on a ring detector for the phone line. Do you have circuits that will detect the busy signal and dial tone?

PAUL J. ROUMANIS
Roanoke, VA

Dial tones, busy signals, ringing tones, and recorder tones are known as call-progress tones. They are easily detected by specialized integrated circuits. One company making such chips is Teltone, 10801 120th Ave. N.E., POB 657, Kirkland, WA 98033, (800) 227-3800 ext. 1130.

Its M-980 is a CMOS call-progress tone detector that monitors dial tone, circuits-busy, station-busy, audible ringing, and other call-routing tones in the 300–640-Hz band. It operates from a single 5-V supply and uses a color-television crystal (3.58 MHz).

The M-982 gives precise detection of the four common call-progress tones and features Tri-state output. It too is powered by a single 5-V supply and uses the 3.58-MHz crystal time base.

My March project is building a Touch-Tone interactive messaging system.
—Steve

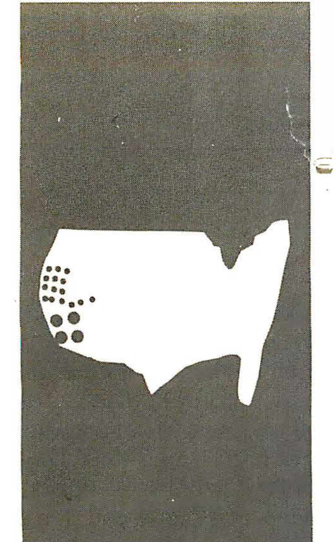
BUT WILL IT WORK IN HOBOKEN?

Dear Steve,

Many thanks for your article about the ECM-103 modem in the March 1983 issue. Here in Switzerland our CCITT-compatible modems use 980 Hz for a 1 and 1270 Hz for a 0 in the originate mode and 1650 Hz for a 1 and 1850 Hz for a 0 in the answer mode. Can I make any modifications so that your modem will work here?

KARL KLINGLER
Zürich, Switzerland

The Texas Instruments TMS99532 modem chip is designed to be Bell-103-compatible and will not work with the CCITT format. However, the TI TMS99534 modem chip is designed for the CCITT format and will work fine, just replace the TMS99532 with the TMS99534 and you have a CCITT-compatible modem.—Steve ■



B·Y·T·E W·E·S·T C·O·A·S·T

Light Touches

Macs, Mice, and Laser Disks

BY JOHN MARKOFF AND PHILLIP ROBINSON

BYTE West Coast is prepared monthly by BYTE's editors and staff in San Francisco and Palo Alto. Correspondence should be addressed to BYTE West Coast, BYTE Magazine, 425 Battery St., San Francisco, CA 94111.

Apple Computer's policy of seeding college campuses with Macintosh computers is starting to bear fruit. On a recent visit to Reed College in Portland, Oregon, we saw a number of commercial-quality programs for the Macintosh. All were developed by students and faculty, under the direction of physics professor Richard Crandall, in the college's newly established "Maclab." Crandall's direction of the Maclab has given him a key role in planning the college's computer future.

The plan is for Reed College to become a heavily computerized liberal arts campus of the future, and the Macintosh software-development effort is just the first step in a five-year program. Ultimately the plan will supply each member of the Reed academic community with a Macintosh computer, link classrooms, dormitories, and administration buildings by means of an Ethernet-type local-area network (LAN), and provide high-bandwidth access to microprocessor-based, timesharing network nodes.

According to Crandall, the people at Reed College are working with the Intel Corporation on the LAN aspect of the five-year program to develop the "ultimate Macintosh network." Their goal is to develop individual, $5000, 32-user, timesharing network nodes that can be distributed around campus. Crandall refers to the network as a "running-water network," in which faculty, students, and administrators will have "taps" into dispersed computing and storage resources. The plan calls for the network to be "iconic," depicting such remote resources as file, communication, and print servers with pictographs.

Reed College has set up a private corporation, Metaresearch Inc., to market products developed in the Maclab. Metaresearch currently offers GriffinTerminal (a terminal program for the Macintosh with Tektronix terminal-emulation capability for $89), GriffinText (a simple text editor), and the EMM-2048a Universal Microcontroller, an Intel 8031 microprocessor-based standalone serial laboratory interface to the Macintosh.

Students and faculty at Reed have developed software and hardware that permit the Macintosh to emulate more expensive laboratory instruments. Simple demonstration projects include a light meter and thermometer written in MacPascal, the interpreted Pascal language developed for Apple by Think Technologies Inc. The light meter displays the logarithmic light intensity measured by a photosensitive cell connected to the Metaresearch EMM computer. A light-meter-type dial is drawn on the Macintosh screen using both Apple's QuickDraw and additional graphics routines. The beefed-up graphics software lets the light-meter program create a picture based on a real-value coordinate system (as opposed to the Macintosh system, which permits only integer values for coordinates). The thermometer program takes temperature data input via the EMM interface and draws a thermometer on the screen with a range of 54 to 104 degrees Fahrenheit. The degrees are five pixels apart on the Macintosh display.

The EMM Universal Microcontroller can be used for a wide range of interfaces—process control, energy management (Reed is already using a similar system for on-campus energy management), and laboratory test management. Up to 256 separate microcontrollers may be networked and controlled by a single terminal or computer with an RS-232C interface. The EMM has 2K bytes of on-board RAM (random-access read/write memory) for program and/or data storage. Monitor software that resides in 4K bytes of ROM (read-only memory) includes communications routines and functions such as selecting a multiplex channel, setting and reading I/O (input/output) ports, accessing the real-time clock, digital-to-analog (D/A) and analog-to-digital (A/D) con-

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Higher-resolution mice cut down work-surface movement while still letting you point to individual pixels.

version, reading the auto-ranging frequency counter, and displaying memory and registers.

The EMM hardware includes both 8-bit and 12-bit CMOS (complementary metal-oxide semiconductor) multiplying D/A converters, comparators for A/D conversion, a 13-bit voltage-to-frequency converter, a real-time clock, onboard SIN (symbolic integrator), and TTL (transistor-transistor logic) square-wave generators, an 8-channel analog CMOS multiplex switch, 16 bits of TTL I/O, eight diode-protected relay drivers, and optoisolated serial communication lines.

In a network, each EMM can be individually addressed and controlled (there is an onboard 8-bit network address jumper), either manually or under program control.

The GriffinTerminal communications program was originally written to provide Reed's Macintosh users with high-speed access to the campus mainframe computers. It has full Tektronix 4012 terminal-emulation capability to let it run graphics programs on the host computers and display the output on the Macintosh. Additionally, GriffinTerminal can be set for data rates ranging up to 38,400 bps. It can save graphics screens in MacPaint format and transfer 8-bit text and graphics files between the Macintosh and host computer. GriffinTerminal lets you control the cursor location with the Macintosh mouse. The software translates mouse movement into *x,y*-coordinates and then sends them back to the host computer.

Tailless Mice

It had to happen. When Metaphor Computer Systems, a recent addition to Silicon Valley, introduced its sleek new information-retrieval system, those who looked closely noticed that the workstation came with a tailless mouse. In fact, founders Donald Massaro and David Liddle also left off the cable for the keyboard and the auxiliary keypad. In its place, they chose an infrared technology that resembles the IBM PCjr keyboard arrangement. There are significant differences, however. The Metaphor infrared transmitter/receiver has a shorter physical range, operates on multiple frequencies, and has a wide field of view (270 degrees).

Metaphor decided to use a cordless mouse because it wanted a highly ergonomic workstation for executives who weren't used to having computers on their desks. The Metaphor mouse is easily used by both left- and right-handed people and comes with a rechargeable nicad (nickel-cadmium) battery. To conserve power, the mouse goes to sleep if you don't use it for more than one minute. It wakes up again when you move it or click one of its buttons. When the mouse isn't in use, you store it (along with the keyboard and two separate keypads) in the terminal's special recharging sockets.

Now that mice are becoming more popular, it has become apparent that their design problems are much more subtle than previously suspected. Issues include resolution, optical versus mechanical technologies, and even the appropriate number of buttons.

Metaphor turned to Logitech, a U.S./Swiss company, for development assistance. For Daniel Borel, a Logitech vice president involved in designing the Metaphor tailless mouse, resolution has become crucial as high-resolution, bit-mapped displays proliferate. In particular, higher-resolution mice cut down work-surface movement while still letting you point to individual pixels. If you use a mouse with a resolution of 200 dots per inch (dpi), says Borel, you should be able to move the cursor from one side of the screen to the other without being forced to lift and reposition your hand.

According to Borel, the Apple Macintosh mouse, which has coarser resolution, gives the illusion of high resolution by employing a "software gearshift" mechanism. When the Macintosh mouse is moved quickly in any direction, the cursor moves several pixels at a time. Borel argues that this is only a partial solution. If the mouse is moved at different rates of speed, he says, it will gradually relocate itself on your desk (i.e., its 0,0 position on an imaginary work surface x,y graph will "drift"), forcing you to pick it up and replace it in its original position on your work surface.

Mice sense motion differently, depending on whether their basic design is mechanical or optical, and each type has its own advantages. Optical mice are generally said to be quieter and more reliable than their mechanical cousins as they have no moving parts. On the other hand, the optical mice require a special reflective surface.

The Logitech mouse employs a hybrid of the two technologies. It has a specially coated metal ball for tracking its movement across the work surface. The coating is important because it makes the mouse significantly quieter and because rubber balls tend to pick up dirt. However, the mouse optically decodes the movement relayed by the ball with photo diodes and sensors inside its housing. This design makes it extremely simple for Logitech to increase the resolution of its mouse; models have been manufactured with resolution in excess of 380 dpi.

The Logitech mouse is also microprocessor controlled and therefore is quite flexible in meeting different protocols. The Motorola 6805 is used in the standard design and a CMOS part was added for Metaphor. It can be reconfigured in firmware to meet either the Summa, Microsoft, or Mouse Systems requirements.

Borel argues that communications speed is an important factor in mouse design. Given the increasing popularity of high-resolution displays (the Metaphor workstation has a resolution of 896 by 960 pixels, and displays of 1024 by 1024 pixels are not all that unusual), he makes the point that you need high bandwidth between the mouse and the system in order to reproduce the mouse's movement accurately. The bit rate of the Logitech product is selectable under program control from a range of 1200 to 9600 bps.

Borel is pleased that Logitech has been successful in gaining a foothold in the growing mouse market. There were times over the past two years, he says, when he was discouraged by

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what seemed the almost universal rejection of the mouse in favor of keyboards. Another factor contributing to his discouragement was the mouse's dependence on slow-to-develop software technology. "People miscalculated the complexity of interfacing the mouse," he notes.

A Laser Disk for Databases

The optical disk drive from Reference Technology won't replace Winchesters; it can only read, not write, data. But its use of cheap, removable disks makes it ideal for "electronic publishing and information distribution"—a phrase that turns up repeatedly in Reference Technology

A Trip to the UNIX Show

September's UNIX Systems Expo/84 in Los Angeles wasn't a huge affair like COMDEX or a West Coast Computer Faire, but a lot of the big guns were there: AT&T, IBM, Honeywell, Digital Equipment Corporation, Tandy, Data General, and so on. Because the show was dedicated to UNIX, rather than personal computers, there were many firms displaying minicomputer software and hardware. However, the interest in microcomputers was obvious. XENIX was running all over the place—on IBM Personal Computers (PCs), Tandy Model 16Bs (one with a Model 100 as a terminal), and Lisas (one with a Macintosh running MacTerminal hooked to the Lisa). IBM was showing PC/IX on ATs and XTs and was selling it for $800 (the list price is $900).

Plenty of people were showing connections between UNIX systems and DOS-type personal computer systems. AT&T, for instance, had one of their 3B2s connected to a 6300 PC. The 6300 could directly call up a DOS application that was stored on the 3B2 hard disk, which was controlled by UNIX.

Another DOS–UNIX link was shown by Computerized Office Services Inc. (COSI). This scheme uses the UNIX machine to direct the workings of various DOS machines. Jeff Spencer of COSI regaled me with the vision of an office of PCs left idle at night transformed into an office where they were left on for the big guy (probably a VAX) to slave drive. The COSI software on the VAX finds a sleepy PC and barks out orders to run this or that application and report back when done.

A different approach, and the one of most immediate use to those with a single system, was exemplified by the first appearance of a product from Uniform Software Systems called The Connector. This program allows DOS to be run as a UNIX (in this case, PC/IX) process. In turn, DOS can then run applications—all without leaving UNIX. The particular advantage of this approach (having DOS under UNIX instead of just co-resident on the disk) is that other UNIX processes can be running simultaneously with the DOS applications. I watched Lotus 1-2-3 running underneath DOS underneath UNIX—all without the XT leaving UNIX. Switching from DOS to UNIX is very simple. DOS is treated as a UNIX process so you don't have to alter any of the UNIX procedures and operations. The Connector comes on a single disk and can then be stored on the hard disk. Entering a command as simple as "dos" lets you move to DOS and "unix" lets you move back.

The Connector automatically sets the DOS date and time from UNIX. To run a DOS application you can enter DOS and then use the standard procedure to call the program. Alternatively, you can create a special link to enter the application call directly from UNIX. Files can also be exchanged between UNIX and DOS.

To run The Connector you need an IBM PC XT with at least 512K bytes of RAM (random-access read/write memory), a dual-sided floppy-disk drive, a 10-megabyte hard disk, PC/IX, PC-DOS (1.0, 1.1, 2.0, or 2.1) and whatever DOS applications you want. The program costs $299, and the PC/IX version was supposed to be available on October 15. The Venix version should see the light of day by December 15.

I was assured there would be no problem getting The Connector up on the IBM PC AT, though it hadn't actually been done by the time I saw it. The only problem, and again I was assured that it is a small problem, is that UNIX runs in the protected mode and DOS in the unprotected.

In an unrelated matter, I wandered into the small Sun Microsystems Inc. booth. The Sun workstation has a 42-megabyte disk, 68010 CPU (central processing unit), 1-megabyte RAM, runs UNIX 4.2 with a proprietary window system, and can drive the screen with magnificent resolution. I asked, just to get the official line, what was the advantage of having this expensive microcomputer over having a terminal hooked to a VAX? A foraging software engineer who was playing with the Sun stopped, glanced dryly at me, turned back to what he was doing, and contributed a few comments about how slow a VAX can get when several engineers are crunching on it.

Finally, there seems to be an interesting relationship between UNIX and men's fashions. While I was watching the melee at the L.A. International Airport rental-car counter, I was told that there weren't any cars available because of The Magic Show. The Magic Show turned out to be a Men's Fashion Extravaganza. Larger than the UNIX show, it was also accorded more importance at the L.A. convention center. The Magic Show had shuttle buses; UNIX did not. The Magic Show got free parking at the Shrine parking lot; when I pulled into that lot, the attendant gave me a quick once-over and said, "UNIX." I agreed, and he directed me back out into the street. When I arrived at the convention center, there were Magic Show people handing out brochures for some rather interesting clothing designs. No one handed one to me. In fact, I failed to fool anyone into thinking that I was attending a fashion show. As the coup de grace, Magic Show attendees got complimentary passes to the UNIX show; UNIX show participants did not get treated in kind. Perhaps it was the miniature red dirigible tethered to the UNIX show's roof. With its three bomb-like fins and its "USE/84" slogan, it looked more like a commentary on arms talks than an invitation to a good time.

—*Phil Robinson*

literature. It isn't inexpensive—$8900 apiece in lots of 100—but it offers direct, fast access to 1 gigabyte of cheaply stored information (a disk costs only $14 in quantity), and the drive's speed makes it a fine candidate for multiuser systems.

Reference Technology, located in Boulder, Colorado, is just beginning to explore this new market. Prior to September, only seven units had been shipped. According to Ronald Rediesel, vice president of strategic marketing, most of the company's sales will be to OEMs (original equipment manufacturers). The OEMs, in turn, will take the disk drive, add a particular set of data, some software, and a controlling computer system, and then resell the entire package.

The Reference Technology CLASIX (Computer/Laser Access Systems for Information Exchange) DataDrive holds 1 gigabyte per disk side. The DataDrive uses a CAV (constant angular velocity) scheme and can transfer data at 1 megabyte per second. There are 51,000 tracks per side, 2 fields per track, 11 planes per field, and 892 bytes in each plane. That yields a data-carrying capacity of 19,624 bytes per track and 15,000 tracks per inch. The average access time is 151 milliseconds, with an average seek time of 125 milliseconds. The disk rotates at 1800 rpm (revolutions per minute) and is read by a single head. It takes the drive about 20 seconds to get the disk up to speed and about 10 seconds to stop it. The significance of the tremendous access speed is apparent when searching through huge databases. The next generation of full-size DataDrives will be coming out in 1987 with better access times and greater storage density, as well as double-sided drives.

The DataDrive uses a standard, prerecorded NTSC (National Television System Committee) videodisc of aluminized acrylic (stamped by the commercial videodisc process) that comes in a plastic carrier. It can hold digital data, still-frame, or full-motion video, and analog or digitized audio.

The entire drive measures 8.4 by 16 by 23.6 inches and weighs 70 pounds. The DataDrive connects to the SCSI interface. With a video option kit, which can be added at the factory or in the field, it can read mixed video, audio, and digital information.

The TRIDECC error-correction and -detection technology is an important element of this system. TRIDECC is a Reference Technology proprietary, three-dimensional, interleaved, Reed-Solomon code with 26 percent redundancy at a data density of 1 gigabyte per disk side. The maker claims that it will correct input-error rates as high as 1 percent and will yield output-error rates of less than 1 in 10 trillion

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bytes. Without excellent error detection and correction, such huge volumes of data would not be useful.

Reference Technology sees OROM (optical read-only memory) augmenting rather than replacing traditional data-storage techniques. Some of OROM's most obvious markets include: library services (card catalogs, bibliographies, indexes); legal services (case and patent law); medical-information services; scientific and technical services (specifications, abstracts, bibliographies); economics, econometric, and financial analysis (data for modeling); and government. A number of companies have already developed applications that showcase the technology.

Strategic Information Corporation, of Burlington, Massachusetts, has developed a multiuser system comprising: two DataDrives, a Micro VAX, the Strategic Information Search Software (Data Visual Management System), several terminals, and the Haystack database. (Two DataDrives were necessary because the database takes up 2 gigabytes.) Haystack contains an index to government military specification data, standards, vendor catalogs, parts, and components.

From NCR/Micromedex Corporation, a multiuser system (built around a single DataDrive, an IBM Personal Computer (PC), an NCR PC, and the NCR 6650 Micro Modus intelligent input/output controller) provides fast access to a hospital database on poisons, toxicology, and pharmacology. The information in the database is already available as an on-line service, but when you bring it into a microcomputer system, you don't have data communications problems or expenses. In fact, this is the sort of application that makes you see how microcomputers can save lives. For instance, by working through a menu quickly, a doctor can call up a particular poison and check effects, therapies, and special dangers—even enter the known data about the victim (sex, weight, and approximate age). The doctor can then have the computer infer related data and display a nomograph showing the risks of particular combinations of drugs.

In another demonstration, an IBM PC was hooked up to a single DataDrive and a Metheus display system. This combination delivered individual images from a National Aeronautics and Space Administration/Jet Propulsion Laboratory (NASA/JPL) library. NASA commissioned the Laboratory for Atmospheric and Space Physics (LASP) to find a way to economically distribute the enormous data from interplanetary exploration missions. That data, claimed to be approximately 10^{15} bits per year and accumulated on magnetic tapes (some stored in a paint shed because there was nowhere else to put it), can now be sent out to those who can use it. Because the data consists of 1024- by 1024-pixel images, 1000 of them fit on a single disk (each pixel requires a single byte to specify color and intensity). The system allows close inspection (and temporary manipulation) of any part of the image. The distribu-

COMPANIES MENTIONED

APPLE COMPUTER INC.
20525 Mariani Ave.
Cupertino, CA 95014
(800) 538-9696
in Canada, (800) 268-7796 or
(800) 268-7637

COMPUTERIZED OFFICE SERVICES INC. (COSI)
313 North First Street
Ann Arbor, MI 48103
(313) 665-8778

INTEL CORP.
3065 Bowers Ave.
Santa Clara, CA 95051
(408) 987-8080

INTERNATIONAL THOMSON/ CARROLLTON PRESS
1611 North Kent Street, Suite 910
Arlington, VA 22209
(703) 525-5940

LASERDATA INC.
1 Kendall Square
Building 200
Cambridge, MA 02139
(617) 494-4900

LOGITECH INC.
805 Veterans Blvd.
Redwood City, CA 94063
(415) 365-9852
in Switzerland, (021) 77 45 45

METAPHOR COMPUTER SYSTEMS
2500 Garcia Ave.
Mountain View, CA 94043
(415) 961-3600

METARESEARCH INC.
1100 Southeast Woodward St.
Portland, OR 97202
(503) 232-1712

NCR/MICROMEDEX CORP.
1700 Patterson Blvd.
Dayton, OH 45479
(513) 445-2380, (513) 445-5000,
(800) 222-1235

REFERENCE TECHNOLOGY INC.
1832 North 55th Street
Boulder, CO 80301
(303) 449-4157

STRATEGIC INFORMATION CORP.
80 Blanchard Rd.
Burlington, MA 01803
(617) 273-5500

SUN MICROSYSTEMS INC.
2550 Garcia Ave.
Mountain View, CA 94043
(415) 960-1300

TEKTRONIX INC.
POB 500, Station Y3-314
Beaverton, OR 97077
(503) 643-7768
(800) 452-1877 or
(800) 547-1512

THINK TECHNOLOGIES INC.
420 Bedford St.
Lexington, MA 02173
(617) 863-5590

UNIFORM SOFTWARE SYSTEMS
201 Santa Monica Blvd.
Santa Monica, CA 90401
(213) 395-9674

tion, storage, and manipulation of images will plainly be revolutionized by such optical disk-storage systems.

An International Thomson/Carrollton Press demonstration showed the DataDrive searching through a library card catalog. Though the catalog was incomplete (covering only education and library-science classifications), the ability to search using keywords and Boolean operations was exciting. International Thomson/Carrollton Press will eventually offer the complete Library of Congress shelflist.

Reference Technology isn't the only company eyeing this market. Laser-Data Inc. of Cambridge, Massachusetts, is making an optical disk-drive controller that personal computer owners can use with commercially available optical disk drives (such as Hitachi and Pioneer). Actually, there are two controllers. The Trio-110, which has an embedded 80186, can control up to four disk drives or players, can work with up to four hosts, and costs $2950 (without the disk player). The PC-Trio is a card for the IBM PC and compatibles. It controls a single player, works with a single host, and costs $1365 (without the disk player). The disk players cost around $1000. The name "Trio" comes from the system's ability to work with video, data, or audio information. Either Trio version holds a mere 800 megabytes per disk but both are substantially slower than the Reference Technology system (an average access time of 1 second compared with the DataDrive's 151 milliseconds).

Another form of competition comes from the audio sector. Such manufacturers as Sony and Philips, who have been selling huge numbers of compact-disk players, which use smaller optical disks as a medium for digitized

Manufacturers such as Sony and Philips are eyeing the data-storage market.

audio signals, are eyeing the data-storage market. Because of the economies of scale afforded them by success in the consumer market, they can experiment with computer applications. Most schemes see the 12-cm (4.68-inch) compact disk holding 550 megabytes and moving that data at 1.44 megabits per second with an average access time of 0.5 second. Reference Technology intends to include a compact-disk ROM in its own line within the next eighteen months. ■

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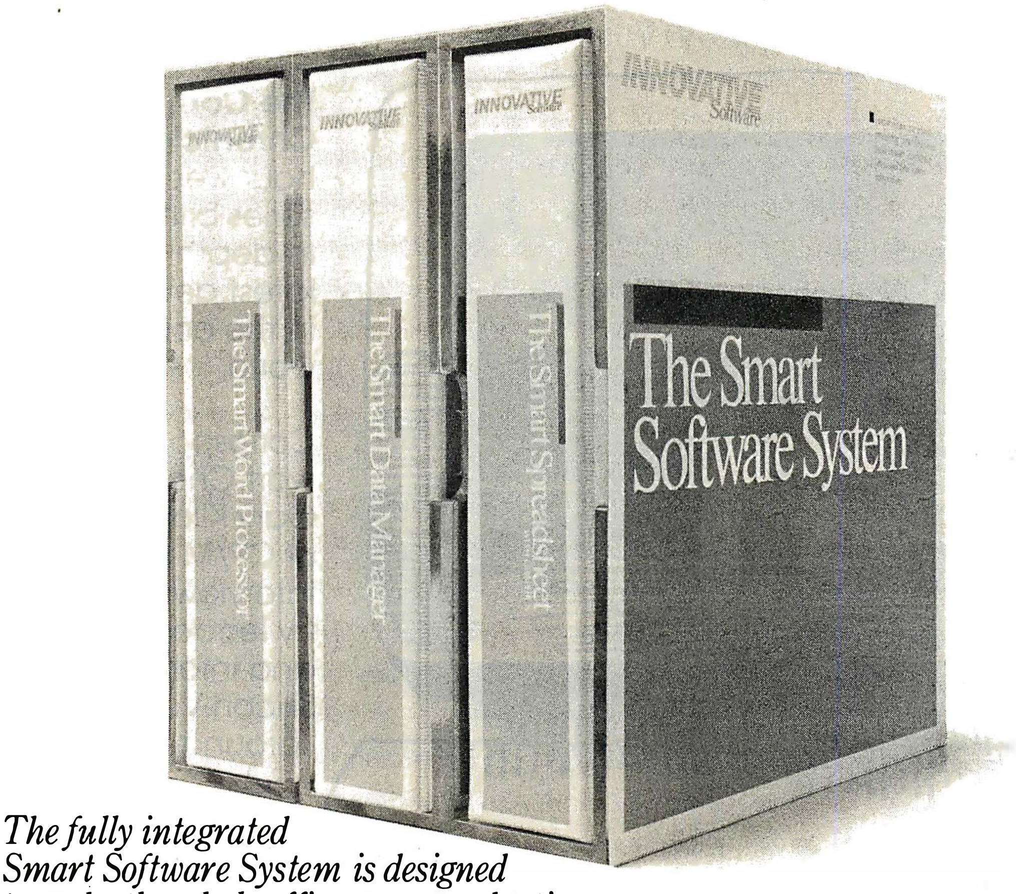
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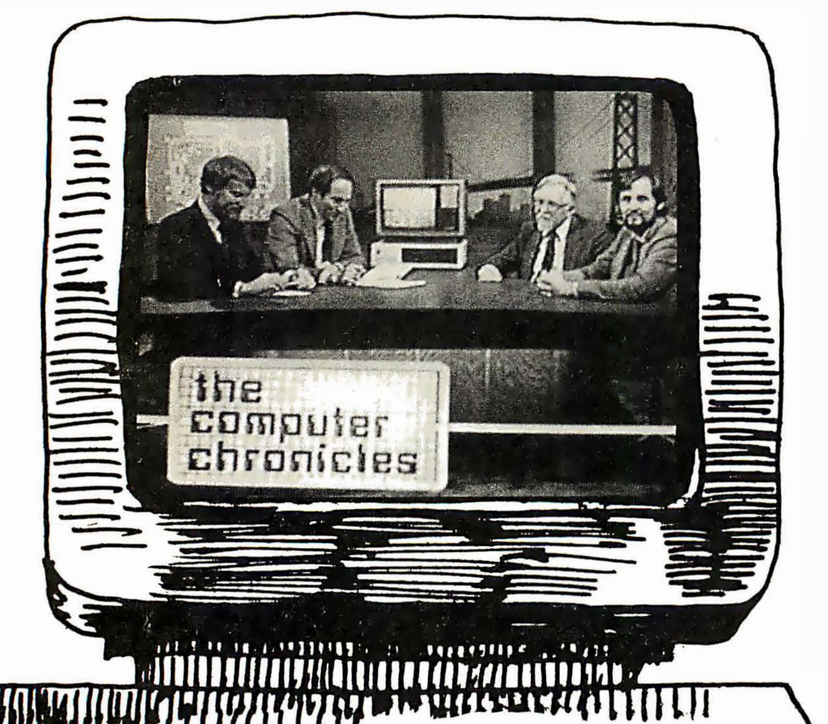
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The Fundamental Counting Principle

Counting without enumerating

BY MICHAEL W. ECKER

You are at a racetrack trying to pick the triple for a race featuring 10 horses. That is, to win you must predict which horses will come in first, second, and third place, with the specific order significant. How many possible triples do you have to choose from?

You wish to choose a fraternity name following the practice of using three Greek letters (e.g., Alpha Beta Alpha), where repetition of letters, as in the example, is allowed. The Greek alphabet has 24 letters. How many possibilities are there?

You want to count the number of divisors of 750. How can you do this without actually finding all the divisors first?

What is the smallest army that can be arranged in rows and columns of consistent sizes in exactly 16 different ways? (To illustrate, an "army" of 14 people could be arranged in four configurations: 1 × 14, 2 × 7, 7 × 2, and 14 × 1.)

These four ostensibly different problems can be handled without recourse to enumeration (meaning lengthy listing of all possibilities). The branch of mathematics dedicated to counting without enumerating is called combinatorics. The most basic theorem of combinatorics, known as the fundamental counting principle, can be stated this way: If a first thing can be done in m ways and a second thing in n ways, then the number of ways in which you could do both things (first one of the m followed by one of the n) is m times n, or mn.

As an example, suppose you wish to travel from A to B and then from B to C, as in figure 1 (without retracing any path or going in the wrong direction). Since you can go two ways from A to B and three ways from B to C, you have 2 × 3 = 6 ways to go from A to C. As a check by direct enumeration, suppose you call the A to B paths u and v, and the B to C paths w, x, and y. Then the possible paths from A to C are the six paths u-w, u-x, u-y, v-w, v-x, and v-y.

The fundamental counting principle is easily proven in general, but I think the enumeration of the possible paths in our example should be convincing (table 1). Note that since you are essentially counting with rows and columns, with all possibilities considered exactly once, the reason why you multiply is clear. This process extends to more than two things being done, as the solutions to the fraternity name question will show.

Since you have 24 choices for the first letter, 24 for the second, and 24 for the third, 24 × 24 × 24 = 13,824 names are possible. If instead the requirements insisted on no repetition of letters, you would have 24 choices for the first letter, 23 for the second (because 1 of the 24 choices can no longer be used), and 22 for the third, thus 24 × 23 × 22 = 12,144 possibilities. The number of names with at least two letters repeated is 13,824 − 12,144 = 1680 names.

Applied to the horse race, where order matters, you could play 10 × 9 × 8 = 720 possible triples. You can now understand why the racetrack can afford to give such luxurious odds. Similarly, you could apply this principle to counting possible numbers of license plates, ways to line up people, etc. In any case, you can appreciate that the numbers in question begin to get large.

FACTORIALS

Combinatorics makes extensive use of factorials. Recall that the factorial of a positive integer n is written "$n!$" and read as "n factorial." The product is found by multiplying n by $n-1$ by $n-2$ . . . and so on down to 1. For instance, 5! = 5 × 4 × 3 × 2 × 1 = 120. Before continuing, you may want to write a BASIC program to compute factorials of small positive integers. You might be able to produce a more useful one than mine, which simply implements the definition and quickly gets into accuracy and precision questions for larger values (listing 1). For technical reasons, 0! is defined to be 1, much as a zeroth power (of a nonzero number) is defined to be 1. (The primary

(continued)

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The number of possible orderings or arrangements of n distinct objects is n factorial.

reason for 0! equaling 1 is so that the formula for combinations $C(n,k)$—arrangements where order is not significant—will be valid even if $k = 0$ or n.)

The connection of factorials to the fundamental counting principle is that the number of possible orderings or arrangements of n distinct objects is $n!$. Thus, four people can line up in 4! = 24 orders; the 10 horses in the race can finish (assuming all finish) in 10! = 3,628,800 different orders.

ARMIES AND PRISONERS

Let's now see what consequences can be derived from all this. Consider the question of how many divisors a given integer has. You probably know that a prime number is a positive integer greater than 1 whose only divisors are 1 and itself. To say that more elegantly, a prime is a natural number that has precisely two divisors. Now take 750. You could enumerate all its divisors, but you don't want to. Instead, think about the following idea. The number 750 is uniquely expressible, apart from order, as $2 \times 3 \times 5 \times 5 \times 5$ or $2 \times 3 \times 5^3$ when delineated as a product of prime numbers.

For a number to be a divisor of 750, it cannot contain any prime that 750 doesn't contain, nor to a higher power. In other words, a typical divisor of 750 has to look like 2 to the power 0 or 1; times 3 to the power 0 or 1; times 5 to the power 0, 1, 2, or 3. Since two choices for the first power are possible, two for the second, and four for the third, there are $2 \times 2 \times 4 = 16$ divisors. In general, if you have prime factorization p to the a, times q to the b, etc., then the number of divisors is $(a + 1)$ times $(b + 1)$ times etc., coming from $a + 1$ choices for power on p, then $b + 1$ for power on q, and so on. The reason you have power + 1 choices for each prime's power is that 0 as a power is an extra choice. You might try writing your own program to calculate the number of divisors of any number. Then compare your version to mine (listing 2).

Factoring and the army problem have a strong similarity since a single configuration of an army corresponds precisely to one means of factoring into two factors, with order mattering. Specifically, a factoring into $j \times k$ corresponds to a divisor j. On the other hand, $k \times j$ corresponds to the other paired divisor k. All this is to say that each configuration corresponds precisely to a choice for the first factor, that is, the first divisor. Hence, the number of configurations equals the number of divisors. As such, since you know the number 750 has 16 divisors, the solution to the army problem is at most 750. Modifying the previous program to finish this should not be too difficult, although it can be done without a computer as well. (For the same problem applied to 64 divisors with a purely mathematical solution, see my article "Some Recreational Applications of Elementary Number Theory," *The Pentagon*, Spring 1982.

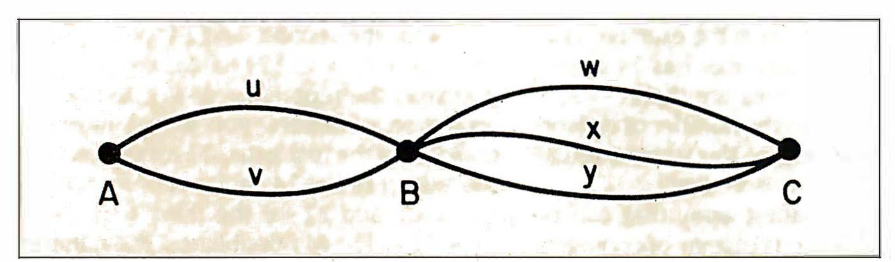


Figure 1: *The two- by three-pathway map.*

Table 1: *The possible paths through figure 1 without backtracking.*

	w	x	y
u	u – w	u – x	u – y
v	v – w	v – x	v – y

Listing 1: *A program to generate factorials through 33!.*

```
10      REM ROUTINE TO COMPUTE FACTORIALS TO 33!, THE LARGEST
        FACTORIAL THAT MICROSOFT BASIC CAN HANDLE IN THIS WAY.
20  CLS
30  DEFDBL F
40  DIM FACTORIAL(33)
50  FACTORIAL(0)=1        'DEFINE 0! TO BE 1.
60              REM COMPUTE FACTORIALS
70   FOR I=1 TO 33
80            FACTORIAL(I)=I*FACTORIAL(I-1)
90   NEXT
100             REM PRINT RESULTS
110 FOR I=0 TO 32 STEP 2
120        PRINT I;"! = ";FACTORIAL(I);TAB(40);I+1;"! = ";FACTORIAL(I+1)
130 NEXT
140 END
```

Still another use of this result from the fundamental counting principle is the following alternate explanation of the jailer problem (Mathematical Recreations, November 1984 BYTE, page 425). In that problem, the prisoners in cells that are open at the end of a certain process to determine a partial amnesty—based on locking and unlocking cell doors—were set free. It turned out that release required, as a necessary and sufficient condition, that the cell number have an odd number of divisors. I showed this condition to be equivalent to the cell number being a perfect square. I will now show a different reason why a number with an odd number of divisors is necessarily a perfect square (and conversely).

If the cell number N is factored as

$$N = p_1^{a_1} p_2^{a_2} \ldots p_j^{a_j}$$

then the number of divisors it has is $(a_1 + 1)(a_2 + 1) \ldots (a_j + 1)$. In order for an integer to be odd, all its factors must be odd, and conversely. Hence, all of $a_1 + 1$, $a_2 + 1$, etc., are odd. But then all of $a_1, a_2, \ldots a_j$ are even. Write $a_1 = 2b_1$, $a_2 = 2b_2$, etc. By virtue of the identity

$$N = p_1^{a_1} p_2^{a_2} \ldots p_j^{a_j} = p_1^{2b_1} p_2^{2b_2} \ldots p_j^{2b_j} = (p_1^{b_1} p_2^{b_2} \ldots p_j^{b_j})^2$$

N is forced to be a perfect square.

Lagniappe

With all the attention mathematicians pay to perfect squares, it might come as a bit of a surprise that there is a formula for producing nonsquares, only nonsquares, in order and without repetition. I will skip discussion or proof of the formula and just give you the program (listing 3).

The key is the formula for the kth nonsquare given in line 30. The result is stored as A. Since the program has an infinite loop, hit your computer's Break key or equivalent when you've seen enough. I have avoided arrays so as not to limit how high you go.

Combinations

I've digressed a bit from the original topic, so let's get back to counting.

(continued)

Listing 2: A *program to count the number of divisors of a number without enumerating the choices.*

```
10  '**************************************************************
20  '*                                                            *
30  '*   PROGRAM TO FACTOR A NUMBER INTO PRODUCTS OF PRIMES      *
40  '*                                                            *
50  '**************************************************************
60  CLS
70  DEFINT A-Z
80  INPUT "Enter largest number to be factored";NUMBER
90  IF NUMBER<2 THEN PRINT "NUMBER MUST BE LARGER THAN 1":GOTO 80
100 REM FIRST, FIND THE NECESSARY PRIMES. FLAG.ARRAY WILL FLAG
        NONPRIME (COMPOSITE) NUMBERS, PRIME ARRAY WILL HOLD
        PRIMES WHEN FOUND. SOME BASICS REQUIRE SHORTER
        VARIABLE NAMES.
110 REM SIEVE ALGORITHM PROVIDED BY WILLIAM F. DOSSETT OF AUSTIN, TX.
120 DIM FLAG.ARRAY(NUMBER),PRIME(NUMBER)
130 COMPOSITE = -1                        'NONPRIME FLAG.ARRAY ELE-
                                           MENT WILL BE GIVEN
                                           TRUTH-VALUE 'T'
140 INDEX=1                               'SUBSCRIPT OF LARGEST
                                           NONEMPTY ENTRY IN PRIME
                                           ARRAY
150 PRIME(INDEX)=2                        'DECLARE 2 PRIME AND
                                           LIMIT PRIME SEARCH TO
                                           ODD NUMBERS
160 REM AVOID UNNECESSARY DUPLICATION IN SEARCH. FIRST NONPRIME ODD
        NUMBER IS 9 (3 SQUARED), FIRST COMPOSITE ODD NUMBER NOT
        DIVISIBLE BY 3 IS 25 (5 SQUARED), ETC.
170 FOR K=3 TO SQR(NUMBER) STEP 2
180     IF FLAG.ARRAY(K) THEN 220          'SKIP TO NEXT PRIME
190     FOR I=K*K TO NUMBER STEP K+K       'FLAG THE ODD NUMBERS IT
                                           DIVIDES
200             FLAG.ARRAY(I)=COMPOSITE
210     NEXT
220 NEXT
230 INPUT "Do you want a listing of the primes found (y/n)";PRIMEPRINT$
240 IF PRIMEPRINT$="y" THEN PRIMEPRINT$="Y"
250         REM COPY ALL PRIMES FOUND TO PRIME ARRAY, PRINT
                    PRIMES IF SO REQUESTED IN 230.
260 FOR I =3 TO NUMBER STEP 2
270     IF NOT FLAG.ARRAY(I) THEN INDEX=INDEX+1:PRIME(INDEX)=I:
                          IF PRIMEPRINT$="Y" THEN
                                       PRINT PRIME(INDEX);
280 NEXT
290 PRINT:PRINT
300 PRIME(INDEX+1)=NUMBER+1               'MARK END OF PRIME ARRAY
                                           IN CASE NUMBER IS PRIME
310 MAXNUMBER=NUMBER                      'SAVE VALUE OF LARGEST
                                           NUMBER GUARANTEED FAC-
                                           TORABLE WITH CURRENT
                                           PRIMES LIST
320 DIVISORS=1                            'INITIALIZE NUMBER OF
                                           DIVISORS COUNTER
330 SUBSCRIPT=1                           'ACTIVE ELEMENT OF PRIME
                                           ARRAY
340 PRIME=PRIME(SUBSCRIPT)
350         REM PRINT UNIQUE FACTORING OF NUMBER
360 PRINT NUMBER;" CAN BE UNIQUELY FACTORED AS:"
```

```
370          REM IF YOUR BASIC DOES NOT SUPPORT 'WHILE...WEND',
                CHANGE LINE 380 TO: IF PRIME>NUMBER THEN 480.
380 WHILE PRIME< =NUMBER
390          REM WHAT POWER OF THE ACTIVE PRIME IS A FACTOR OF THE
                NUMBER?
                NOTE THAT, ALTHOUGH ALL VARIABLES HAVE BEEN DE-
                CLARED INTEGER, NUMBER/PRIME NEED NOT HAVE AN
                INTEGER VALUE.
400       IF NUMBER/PRIME=INT(NUMBER/PRIME) THEN
                EXPONENT=EXPONENT+1:
                NUMBER=NUMBER/PRIME:GOTO 400
410          REM PRINT THE RUNNING RESULTS, INCREMENT DIVISORS
420       IF EXPONENT>0 THEN PRINT "("; PRIME;"TO THE";EXPONENT;")";:
                          DIVISORS=DIVISORS*(EXPONENT+1)
430          REM RESET POWER COUNTER, LOOP
440       EXPONENT=0
450       SUBSCRIPT=SUBSCRIPT+1:PRIME=PRIME(SUBSCRIPT)
460 WEND
470          REM IF YOUR BASIC DOES NOT SUPPORT 'WHILE...WEND',
                CHANGE LINE 460 TO: GOTO 380
480 PRINT:PRINT "NUMBER OF DIVISORS=";DIVISORS
490 PRINT:PRINT
500          REM IF MORE NUMBERS ARE TO BE FACTORED, DETERMINE
                WHETHER THE CURRENT PRIMES LIST IS ADEQUATE. IF
                SO, USE IT. IF NOT, ERASE ARRAYS TO AVOID PROGRAM
                CRASH AND RECALCULATE PRIMES.
510 INPUT "Do you want to factor another number (y/n)"; CHOICE$
520 IF CHOICE$< >"y" AND CHOICE$< >"Y" THEN 560
530 CLS
540 INPUT "Enter the new number to be factored";NUMBER
550 IF NUMBER< =MAXNUMBER THEN 320 ELSE
    ERASE FLAG.ARRAY,PRIME:GOTO 120
560 END
```

Listing 3: A *program to generate nonsquare numbers.*

```
10    REM ROUTINE TO GENERATE NONSQUARE NATURAL NUMBERS.
         PROGRAM CREATES AN INFINITE LOOP. HIT THE BREAK KEY
            TO TERMINATE.
20 CLS
30 COUNTER=1
40 NONSQUARE=INT (COUNTER+SQR(COUNTER)+.5)
50       PRINT "Nonsquare number"; COUNTER;" is";NONSQUARE
60       COUNTER=COUNTER+1
70 GOTO 40
```

Suppose you have a situation in which you have choices where the order doesn't matter. To dramatize the distinction, consider the following two questions:

1. From 10 people, a president, vice-president, and secretary are to be chosen. How many slates of candidates are possible?

2. From 10 people, a clean-up committee of 3 people is to be formed. How many such committees are possible?

The distinction is this: In the first situation, order is significant. *A, B, C* is not the same as *B, C, A* since it is of interest not just which three people are chosen but which holds which

A number with an odd number of divisors is necessarily a perfect square.

office. In the second case, order is not relevant. From these considerations, you discover that the fundamental counting principle applies to the first situation but not to the second. The number of possible slates for candidates is $10 \times 9 \times 8 = 720$.

The solution to question 1 can assist you in handling question 2. For each clean-up committee (*A, B, C*) chosen, there are $3! = 6$ possible slates, namely *A, B, C*; *A, C, B*; *B, A, C*; *B, C, A*; *C, A, B*; and *C, B, A*. In other words, there are six (3!) times as many slates as clean-up committees, or the number of clean-up committees is one-sixth the number of slates; in this case, $720/6 = 120$. More generally, let $C(n,k)$ represent the number of ways to choose k different things from n without regard for the order of choice. If order mattered, you would have $n \times (n-1) \times (n-2) \times \ldots \times (n-k+1)$ possibilities. But because each choice of k things has been counted $k!$ times, this answer is $k!$ times too large. If you now divide by $k!$, you will have a representation for $C(n,k)$. However, you customarily multiply top and bottom by $(n-k)!$ to tidy up the numerator so that it contains only a factorial. Then $C(n,k) = n!/(k!(n-k)!)$.

As a quick example, how many choices do you have if you wish to pick 3 distinct flavors from a choice of 31 flavors? Since the order of choice is irrelevant, there are $C(31,3) = 31!/(3!28!)$ choices. In practice, you would not compute 31! first, but rather would simplify first—$31 \times 30 \times 29/6 = 4495$.

After the foregoing, you should find it easy to write a program to calculate combinations. ■



B·Y·T·E J·A·P·A·N

The New and the Old

Denser Chips
NEC PC-8401A
Casio LCS-2400
Fujitsu FM-11BS
Piracy

BY WILLIAM M. RAIKE

William M. Raike, who holds a Ph.D. in applied mathematics from Northwestern University, has taught operations research and computer science in Austin, Texas, and Monterey, California. He holds a patent on a voice scrambler and was formerly an officer of Cryptext Corporation in the United States. In 1980, he went to Japan looking for 64K-bit RAMs. He has been there ever since as a technical translator and a software developer.

I have just spent the last two weeks exploring the quirks and idiosyncrasies of my new Fujitsu FM-11BS, my first 16-bit machine, and I happily admit that I'm delighted with it. I'll say more about it later in this column. Meanwhile, there's news about integrated circuits (ICs), a report from my own source about a new hand-held computer from NEC, an announcement of a new printer from Casio, and some comments about the burgeoning market in pirated software in Taiwan.

MITSUBISHI'S TINY TRANSISTORS

It seems as if every week there's an announcement of some "revolutionary breakthrough" in IC technology that makes the previous week's revolutionary breakthrough seem old. My candidate for this week's mind-blowing achievement award is Mitsubishi Electric. They have just announced the development of what they call "submicron-wafer processing technology," which can produce the types of thin wafer-like plates from which the next generation of extremely large-scale memory chips will be manufactured. Mitsubishi produced sample wafers that contain transistors small enough to build 4-megabit (half-million character) dynamic RAM (random-access read/write memory) chips.

The newest generation of memory chips is the 256K-bit chip; the impact of these ICs, which can hold over 32K bytes each, is just starting to be felt by designers who can now put 246K bytes of memory in the same circuit-board area that previously held only 64K bytes. In order to cram enough microscopic transistors into the space of a single chip to hold that volume of data, the photographically produced lines on the chip can be only a few microns wide. (A micron is one-millionth of a meter.) For a 4-megabit RAM chip, the lines need to be almost an order of magnitude slimmer. Mitsubishi succeeded in making transistors with lines only 0.4 micron wide. For comparison, the wavelength of violet light is only about 0.45 micron.

It's too soon to predict who will be first into the marketplace with a 4-megabit RAM (or a 1-megabit RAM, for that matter), but this development means that technology that would have been considered esoteric even for research labs only a few years ago is coming closer to the production line.

NEW NEC HAND-HELD COMPUTER

Last month's BYTE Japan talked about the new hand-held computers from Epson and the 68000-based, APL-oriented machine that Ampere Corporation will be introducing soon. This month we bring you a peek at the recently released NEC portable, the PC-8401A. (See What's New, December 1984 BYTE, page 39.) It is a substantial upgrade of the handy little PC-8201 and is clearly intended to compete with the machines already being marketed in the U.S. by Hewlett-Packard, Epson, and others.

The PC-8401A will be based on NEC's CMOS (complementary metal-oxide semiconductor) version of the Z80 processor; the operating system will be a version of CP/M in ROM (read-only memory). The machine will have a liquid-crystal display (LCD) with 16 lines of 80 characters each (128 by 480 dots) and will include both a Centronics-type printer interface and an RS-232C interface as standard equipment. It will be supplied with 64K bytes of RAM, plus at least 96K bytes of ROM to hold the standard software supplied with the computer, which will include portable WordStar, spreadsheet and filing programs, and a telecommunications program.

The telecommunications program will support the built-in 300-bps (bits per second) auto-dial modem, including a feature that will select telephone numbers from a telephone-directory file and will be able to upload and download files either with or without the popular XMODEM protocol. You'll be able to store frequently used log-on procedures in files and to check the names of all current files at any time using

(continued)

The PC-8401A sounds like a powerful, usable machine, if not as dramatic as some others.

an on-the-fly directory command.

Two CP/M modes will be available: 32K-byte mode and 64K-byte mode. In 32K mode, half of the built-in 64K RAM will be used as a RAM disk for rapid-access file storage. In 64K mode, the transient program area available for application programs will be a full 60K bytes, but in that case either an optional 320K-byte microfloppy disk unit or a 32K-byte RAM cartridge will have to be connected in order to provide external file storage. Other options said to be available will include 32K-byte ROM cartridges for user programs, a 1200-bps modem, and an expansion unit containing a standard CRT (cathode-ray tube) interface and a floppy-disk interface. Another option that sounds interesting is a ROM cartridge with a built-in spelling-checker dictionary.

All in all, the PC-8401A sounds like a powerful, usable machine, even if it's not as dramatic as some of the other current (and prospective) offerings.

NEW CASIO PRINTER

In a future column, I'll survey some of the printers available here in Japan for use with personal and office-type computers ("pasocom" and "ofcon"). Meanwhile, the latest high-tech entry is the new LCS-2400, just announced by Casio; first shipments are expected in the second quarter of 1985. It's billed as a desktop machine, even though it weighs over 70 pounds. It uses the same printing method used in electrostatic copying machines. There's no moving print head at all; instead, the characters are transferred to the photoconductive surface through a liquid-crystal shutter, which should produce very clear characters. The LCS-2400 can print nine standard-size pages per minute, with a resolution of 240 dots per inch.

The Japanese price will be equivalent to about $1650.

HAPPINESS IS A NEW COMPUTER

I had a number of reasons for looking for a new computer, besides the slow screen functions on my NEC PC-8801. I finally settled on the Fujitsu FM-11BS. It uses separate microprocessors as display and keyboard handlers to reduce the load on the main processor, which is an 8088 type that runs at 8 MHz.

First, I wanted to be able to run and evaluate contemporary 16-bit software. The FM-11 can run either Digital Research's CP/M-86 or Microsoft's MS-DOS operating system, although the machine is supplied with Fujitsu's version of Kanji CP/M-86, which supports a large Japanese-language character set. It's also supplied with a fairly elaborate dialect of BASIC, plus a Japanese-language word processor called JWORD. The last few weeks have been so busy, though, that I haven't even had time to take the JWORD disk out of its envelope. I also have a Z80 card on order, so I'll be able to run a considerable amount of my existing 8-bit software.

Another reason for selecting the Fujitsu machine was that I'm completely sold on RAM disks. The FM-11 is supplied with 256K bytes of RAM and is expandable to 1 megabyte (MB); I've ordered an additional 256K-byte memory board (for about $300). With jumpers on that board to accommodate 256K-bit RAM chips, I should have my megabyte in less than a month. I can use up to 512K bytes of the available memory as a RAM disk under Fujitsu's version of Kanji CP/M-86. WordStar works with blinding speed when it is located in the RAM disk along with its overlay and message files. When the new memory board arrives, I'll be able to load all the C compiler, linker, and library files into a 512K-byte RAM disk and really sizzle.

Finally, I had gotten tired of disk swapping. With my old 320K-byte drives, I had a text editor on one disk, the compiler, assembler, and debugger on another, and source library and archives on a third. In addition to the time it took to switch disks and/or copy files, there was always the problem of remembering just what files were in which drive at any given time. That's the kind of thing computers are supposed to keep track of. The FM-11 has dual 1-MB 5¼-inch disk drives (with the same track and sector format as 8-inch floppy disks); the large capacity saves me considerable time during the edit-compile-debug cycle. And it's delightful to be able to simply assume that everything I'm currently working on is in drive A (or in drive M, which is the RAM disk). The next logical step is Fujitsu's 10- or 20-MB hard disk, but at the moment that looks postponable.

Software conversion has been fairly hassle-free. It was simple to download my C-language source files directly, with the machines side by side, through the RS-232C ports. I'm running Digital Research's C compiler, and converting my Software Toolworks C/80 source programs for use on the Fujitsu required only modest effort. In a few cases the conversion turned out to be a pain in the neck, due largely to Digital Research's baroque approach to documentation and software "features." For instance, as far as I can tell, CP/M-86 retains such quirks from CP/M-80 as converting the command line to uppercase letters but no longer copies the full command-line tail (containing options, parameters, etc.) into a buffer for use by application programs. That made it tricky to convert the command-line batch submission utility I presented in the November 1984 BYTE Japan (page 401), which does its own parsing of the command line. I finally settled on the kludge of picking up the entire command line out of the CCP's (console command processor) own buffer.

I'm as anxious to try out new software as the next person, but not at the price of encouraging piracy.

Another problem arose when I tried to convert the CDIR do-it-yourself directory program presented in the August 1984 column (page 339). Digital Research's C compiler has a "feature" that automatically treats asterisks or question marks in the command line as CP/M wild-card file specifications and expands them on the spot before passing them to the main C routine via the argc and argv parameters. The expansion apparently cannot be disabled, and evidently it never occurred to Digital Research that there might be cases where it would be undesirable. Still worse, if there are no files that match the wildcard specification, the run-time module prints a gratuitous "No Match" message to that effect on the console, whether you want it or not.

Still another feature is that there are 27 different compiler options that you can specify on the command line, but there's no way to change the default values of the options (such as locations of standard files, the levels of message and error output you want, etc.). My C/80 compiler, which costs about one-fifth the price, comes with a configuration program that lets you change the compiler's default options.

PIRACY

A friend of mine returned recently from a week-long business trip to Taipei. I hadn't been there in nearly three years and was anxious to learn whether the people were still as kind, the food as delicious, and the city as busy as I remembered. The answer to all three questions was "yes," but an active new industry seems to have emerged: software piracy. Years ago, Taipei was notorious as a source of unauthorized (pirated) copies of books, especially English-language technical and reference books. Bowing to international pressure, the government gradually made it more difficult for the pirates to operate, and in recent years the production of pirated books has been reduced to a bare trickle. But with the worldwide microcomputer explosion, a whole new fertile field has presented itself, and the enterprising citizens in Taipei have been copying floppy disks even faster than they used to run their printing presses.

Literally dozens of computer shops have sprung up near Pateh Road and all offer lists of hundreds of well-known U.S.-produced software packages, usually in either IBM PC or Apple disk formats, for $10 to $12 each. Now it may simply be my suspicious nature, but I doubt that those shops could buy legitimate copies of Lotus 1-2-3, dBASE II, or WordStar and make a profit by selling them for $10.

I'm as anxious to try out new software as the next person but not at the price of encouraging piracy. The U.S. Customs Service, quite properly, takes a very dim view of trying to bring bootleg software back into the United States, but total control is impossible, and the potential market outside the U.S. is very large. If carried to extremes, software piracy will only make it unprofitable, and therefore impossible, for high-quality software to be produced and marketed.

Copy protection is not the answer; Jerry Pournelle's Chaos Manor column has given plenty of reasons why that approach is both unreasonable and impractical. In the end, the solution to software piracy is probably the same solution that works for any kind of piracy: apply enough pressure to discourage the countries that harbor pirates from giving them the shelter they need.

NEXT MONTH

In the Feburary BYTE Japan I'll report on some interesting optical disks and laser printers I saw at the 1984 Data Show in Harumi. I'll also discuss the Toshiba MS-X computer and some other tidbits. ■

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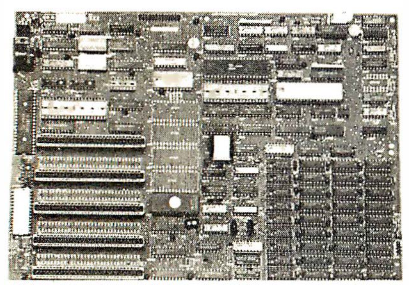
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COMPUTERS: THE NON-TECHNOLOGICAL (HUMAN) FACTORS, John L. Burch, ed. Lawrence, KS: The Report Store, 1984; 106 pages, 17.3 by 21.3 cm, softcover, ISBN 0-916313-00-X, $34.50.

COMPUTERSPACE: HOME DESIGN STRATEGIES THAT WORK FOR COMPUTERS, James Wagenvoord. New York: Perigee Books, 1984; 128 pages, 18.8 by 23 cm, softcover, ISBN 0-399-51020-6, $14.95.

COMPUTING FOR PROFITS, Allan H. Schmidt and Ira Alterman. New York: Macmillan Publishing, 1984; 320 pages, 14 by 21 cm, softcover, ISBN 0-02-008760-8, $10.95.

CONTEMPORARY BUSINESS LETTERS WITH APPLE WRITER II FOR THE IIE, Jane E. Robbins and Kate Lee Johnson. Somerville, MA: Curtin & London, 1984; 240 pages, 21.3 by 27.8 cm, softcover, ISBN 0-930764-80-3, $19.50.

COPING: SURVIVAL IN A COMPUTERIZED SOCIETY, Robert S. Cheney and Jean E. Cheney. Princeton, NJ: Petrocelli Books, 1984; 230 pages, 15.5 by 23.3 cm, softcover, ISBN 0-89433-232-5, $19.95.

CREATING COURSEWARE, Ruth K. Landa. New York: Harper & Row, 1984; 318 pages, 20.5 by 27 cm, spiral-bound, ISBN 0-06-043837-1, $20.95.

DIGITAL COMMUNICATIONS PROGRAMMING ON THE IBM PC, W.

(continued)

THIS IS A LIST *of books recently received at* BYTE *Publications. The list is not meant to be exhaustive, its purpose is to acquaint* BYTE *readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.*

BOOKS RECEIVED

David Schwaderer. New York: John Wiley & Sons, 1984; 352 pages, 17 by 25 cm, softcover, ISBN 0-471-89016-2, $47.90. Includes floppy disk.

EASY INTERFACING PROJECTS FOR THE VIC-20, Jim Downey, Don Rindsberg, and William Isherwood. Englewood Cliffs, NJ: Prentice-Hall, 1984; 176 pages, 17.5 by 23.3 cm, softcover, ISBN 0-13-223421-1, $10.95.

ELECTRONIC LIFE, Michael Crichton. New York: Ballantine Books, 1983; 276 pages, 10.5 by 17.5 cm, softcover, ISBN 0-345-31739-4, $3.95.

50 SIMPLE, READY-TO-RUN VIC-20 PROGRAMS, Barbara Fulgham. Blue Ridge Summit, PA: Tab Books, 1984; 176 pages, 18.8 by 23.3 cm, softcover, ISBN 0-8306-1754-X, $6.95.

GETTING INTO COMPUTERS, Kurt Hanks. Chatsworth, CA: Datamost, 1984; 128 pages, 20.8 by 27.5 cm, softcover, ISBN 0-88190-395-7, $12.95.

GRAPHICS MADE EASY FOR THE IBM PC AND XT, Gabriel Cuellar. Reston, VA: Reston Publishing, 1984; 464 pages, 17.8 by 23.3 cm, softcover, ISBN 0-8359-2569-2, $18.95.

HANDBOOK OF APPLESOFT BASIC FOR THE APPLE II AND IIE, Roy Earl Myers and David I. Schneider. Bowie, MD: Brady Communications Co., 1984; 336 pages, 17.5 by 23.3 cm, softcover, ISBN 0-89303-504-1, $16.95.

HANDBOOK OF BASIC FOR THE COMMODORE 64, Frederick E. Mosher and David I. Schneider. Bowie, MD: Robert J. Brady Co., 1984; 368 pages, 17.8 by 23.5 cm, softcover, ISBN 0-89303-505-X, $14.95.

HANDBOOK OF COMPUTER APPLICATIONS FOR THE SMALL OR MEDIUM-SIZED BUSINESS, Howard Falk. Radnor, PA: Chilton Book Co., 1983; 350 pages, 18.3 by 23 cm, softcover, ISBN 0-8019-7393-7, $19.95.

HARNESSING INFORMATION TECHNOLOGIES, Carolyn J. Mullins and Thomas W. West. Englewood Cliffs, NJ: Prentice-Hall, 1984; 256 pages, 17.3 by 23.3 cm, softcover, ISBN 0-13-383829-3, $10.95.

HOUSEHOLD BUDGETING AND ACCOUNTING ON YOUR HOME COMPUTER, Fred N. Grayson. New York: Perigee Books, 1984; 96 pages, 20.5 by 27.3 cm, softcover, ISBN 0-399-50986-0, $5.95.

THE IBM PC AND ITS APPLICATIONS, Laurence Press. New York: John Wiley & Sons, 1984; 366 pages, 17 by 25.3 cm, software, ISBN 0-471-88440-5, $14.95.

THE IBM PCJR USER'S GUIDE, Michael Bane. New York: Macmillan Publishing, 1984; 126 pages, 13.5 by 21 cm, softcover, ISBN 0-02-008810-8, $5.95.

THE IBM PC/XT GRAPHICS BOOK, John Fowler. Englewood Cliffs, NJ: Prentice-Hall, 1984; 366 pages, 17.8 by 23.3 cm, softcover, ISBN 0-13-448416-9, $29.95. Includes floppy disk.

THE ILLUSTRATED MS-DOS-WORDSTAR HANDBOOK, Russell A. Stultz. Englewood Cliffs, NJ: Prentice-Hall, 1984; 288 pages, 15.3 by 22.5 cm, softcover, ISBN 0-13-451089-5, $14.95.

LEARN TO TYPE ON YOUR HOME COMPUTER, Fred N. Grayson. New York: Perigee Books, 1984; 96 pages, 20.5 by 27.3 cm, softcover, ISBN 0-399-50991-7, $5.95.

LEARNING TI 99/4A HOME COMPUTER ASSEMBLY LANGUAGE PROGRAMMING, Ira McComic. Plano, TX: Wordware Publishing, 1984; 344 pages, 19 by 23.3 cm, softcover, ISBN 0-13-527862-7, $16.95.

LEARNING WITH APPLE LOGO, Daniel Watt. New York: McGraw-Hill, 1984; 336 pages, 20.5 by 27.8 cm, spiral-bound, ISBN 0-07-068571-1, $19.95.

LET'S LEARN BASIC, A KIDS' INTRODUCTION TO BASIC PROGRAMMING ON IBM PERSONAL COMPUTERS, Ben Shneiderman. Boston, MA: Little, Brown and Co., 1984; 208 pages, 19 by 23.3 cm, softcover, ISBN 0-316-78726-4, $8.95.

LET'S LEARN BASIC, A KIDS' INTRODUCTION TO BASIC PROGRAM-

BOOKS RECEIVED

MING ON THE COMMODORE 64, Ben Shneiderman. Boston, MA: Little, Brown and Co., 1984; 208 pages, 19 by 23.3 cm, softcover, ISBN 0-316-78725-6, $8.95.

LOGIC AND MACHINES: DECISION PROBLEMS AND COMPLEXITY, E. Borger, G. Hasenjaeger, and D. Rodding, eds. Lecture Notes in Computer Science #171. New York: Springer-Verlag, 1984; 464 pages, 16.5 by 24 cm, softcover, ISBN 0-387-13331-3, $20.

LOTUS 1-2-3 SIMPLIFIED, David Bolocan. Blue Ridge Summit, PA: Tab Books, 1984; 192 pages, 18.8 by 23.5 cm, softcover, ISBN 0-8306-1748-X, $10.25.

MICROCOMPUTING IN SPORT AND PHYSICAL EDUCATION, David A. Brodie and John J. Thornhill. New York: Sterling Publishing Co., 1983; 160 pages, 19.8 by 25.3 cm, hardcover, ISBN 0-86019-106-0, $16.95.

MICROPROCESSORS: HARDWARE AND APPLICATIONS, Andrew Veronis. Reston, VA: Reston Publishing, 1984; 944 pages, 18.5 by 24.3 cm, hardcover, ISBN 0-8359-4382-8, $34.95.

MICROS, MINIS AND MAINFRAMES, D. Michael Werner and Thomas W. Warrner. Radnor, PA: Chilton Book Co., 1984; 420 pages, 18.5 by 22.8 cm, softcover, ISBN 0-8019-7303-1, $19.95.

MR. BABBAGE'S SECRET, Ole Immanuel Franksen. Birkerod, Denmark: Strandbergs Forlag, 1984; 320 pages, 17.8 by 22 cm, hardcover, ISBN 87-872-0086-4, $30.

MODERN INTELLECTUAL PROPERTY, Michael A. Epstein. Clinton, NJ: Harcourt Brace Jovanovich, 1984; 650 pages, 19 by 25.3 cm, 5-punch binder, ISBN 0-15-004367-8, $75.

101 PROGRAMMING SURPRISES & TRICKS FOR YOUR APPLE II/IIE COMPUTER, David L. Heiserman. Blue Ridge Summit, PA: Tab Books, 1984; 208 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1721-3, $11.50.

101 PROGRAMMING SURPRISES & TRICKS FOR YOUR ATARI COMPUTER, David L. Heiserman. Blue Ridge Summit, PA: Tab Books, 1984; 208 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1731-0, $11.50.

101 PROGRAMMING SURPRISES & TRICKS FOR YOUR IBM PC COMPUTER, David L. Heiserman. Blue Ridge Summit, PA: Tab Books, 1984; 208 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1711-6, $11.50.

101 PROGRAMMING SURPRISES & TRICKS FOR YOUR TRS-80 COMPUTER, David L. Heiserman. Blue Ridge Summit, PA: Tab Books, 1984; 208 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1741-8, $11.50.

ONLINE GUIDE FOR THE COMMODORE COMPUTERS, Mike Cane. New York: New American Library, 1984; 400 pages, 15.3 by 22.8 cm, softcover, ISBN 0-451-82084-3, $9.95.

THE OSBORNE/MCGRAW-HILL MS-DOS USER'S GUIDE, Paul Hoffman and Tamara Nicoloff. Berkeley, CA: Osborne/McGraw-Hill, 1984; 218 pages, 18.8 by 23.3 cm, softcover, ISBN 0-88134-131-2, $17.95.

PC GRAPHICS, Dick Conklin. New York: John Wiley & Sons, 1983; 192 pages, 17 by 25 cm, softcover, ISBN 0-471-89207-6, $15.95.

PERFECT WRITER MADE PERFECTLY CLEAR, Elyse Sommer. Radnor, PA: Chilton Book Co., 1984; 190 pages, 18.5 by 22.8 cm, softcover, ISBN 0-8019-7427-5, $12.95.

PERSONAL COMPUTERS FOR THE SUCCESSFUL SMALL BUSINESS, Donald Hockney. New York: Macmillan Publishing Co., 1984; 208 pages, 16.3 by 24 cm, hardcover, ISBN 0-02-551870-4, $19.95.

PERSONAL MONEY MANAGEMENT WITH YOUR MICRO, Wendy L. Milner. Blue Ridge Summit, PA: Tab Books, 1984; 240 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1709-4, $13.50.

POCKET COMPUTING POWER!, Henry Mullish and Richard Kestenbaum. New York: Harper & Row, 1984; 192 pages, 15.5 by 23.5 cm, softcover, ISBN 0-06-044659-5, $12.95.

(continued)

BOOKS RECEIVED

THE POWER OF: APPLEWORKS, Robert E. Williams. Portland, OR: Management Information Source, 1984; 238 pages, 21 by 27.5 cm, softcover, ISBN 0-943518-16-4, $19.95.

PROGRAMMING THE IBM PC & XT, Clarence B. Germain. Bowie, MD: Robert J. Brady Co., 1984; 346 pages, 17.8 by 23.5 cm, softcover, ISBN 0-89303-783-4, $19.95.

THE RESTON DIRECTORY OF ON-LINE DATABASES, Jay M. Shafritz and Louise Alexander. Reston, VA: Reston Publishing, 1984; 254 pages, 21.5 by 28 cm, softcover, ISBN 0-8359-6666-6, $17.95.

SELECTING THE RIGHT DATA BASE SOFTWARE FOR THE IBM PC, Kathleen McHugh and Veronica Corchado. Berkeley, CA: Sybex, 1984; 128 pages, 15.3 by 22.8 cm, softcover, ISBN 0-89588-174-8, $6.95.

SELECTING THE RIGHT SPREADSHEET SOFTWARE FOR THE IBM PC, Kathleen McHugh and Veronica Corchado. Berkeley, CA: Sybex, 1984; 142 pages, 15.3 by 22.8 cm, softcover, ISBN 0-89588-178-0, $6.95.

SELECTING THE RIGHT WORD PROCESSING SOFTWARE FOR THE IBM PC, Kathleen McHugh and Veronica Corchado. Berkeley, CA: Sybex, 1984; 114 pages, 15.3 by 22.8 cm, softcover, ISBN 0-89588-177-2, $6.95.

SHAPES AND SOUNDS FOR THE ATARI, Herb Moore. New York: John Wiley & Sons, 1984; 132 pages, 13.8 by 21.5 cm, softcover, ISBN 0-471-88547-9, $45. Includes two floppy disks.

SIMPLIFIED BASIC PROGRAMMING FOR MICROCOMPUTERS, Gerald A. Silver and Myrna Silver. New York: Harper & Row, 1984; 320 pages, 18.8 by 23.5 cm, softcover, ISBN 0-06-046162-4, $15.95.

SMALL BUSINESS PROGRAMS FOR THE COMMODORE 64, S. Roberts. Holzkirchen, West Germany: Ing. W. Hofacker GmbH, 1984; 136 pages, 13 by 21 cm, softcover, ISBN 3-88963-186-X, $9.95.

SMALL BUSINESS PROGRAMS FOR THE IBM PC, F. Ende. Holzkirchen, West Germany: Ing. W. Hofacker GmbH, 1984; 120 pages, 13 by 21 cm, softcover, ISBN 3-88963-052-9, $12.95.

SMART BASIC FOR THE ADAM, Bill Searle and Donna Jones. Bowie, MD: Robert J. Brady Co., 1984; 384 pages, 17.8 by 23.5 cm, softcover, ISBN 0-89303-846-6, $11.95.

THE SOFTWARE CATALOG, Spring 1984 ed. New York: Elsevier Science Publishing Co., 1984; 1412 pages, 21.3 by 27.8 cm, softcover, ISBN 0-444-00914-0, $75.

THE STATE-OF-THE-ART ROBOT CATALOG, Phil Berger. New York: Dodd, Mead & Co., 1984; 160 pages, 19 by 23.3 cm, softcover, ISBN 0-396-08361-7, $12.95.

TRS-80 MODELS III & 4, Larry Joel Goldstein. Bowie, MD: Brady Communications Co., 1984; 320 pages, 17.8 by 23.5 cm, softcover, ISBN 0-89303-903-9, $15.95.

UNIX ON THE IBM PC, William B. Twitty. Englewood Cliffs, NJ: Prentice-Hall, 1984; 224 pages, 15 by 22.3 cm, softcover, ISBN 0-13-939075-8, $14.95.

THE UNIX SYSTEM ENCYCLOPEDIA. Los Altos, CA: Yates Ventures, 1984; 448 pages, 21.3 by 27.3 cm, softcover, ISBN 0-917195-00-0, $34.95.

USING & PROGRAMMING THE MACINTOSH, Frederick Holtz. Blue Ridge Summit, PA: Tab Books, 1984; 254 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1840-6, $12.50.

USING MICROSOFT COMPILED BASIC, Murray L. Lesser. New York: McGraw-Hill, 1985; 288 pages, 15 by 22.8 cm, softcover, ISBN 0-07-037302-7, $16.95.

USING THE IBM PCJR, Kenniston W. Lord Jr. New York: Van Nostrand Reinhold, 1984; 384 pages, 15.3 by 22.8 cm, softcover, ISBN 0-442-25964-6, $16.50. ■

a message to our subscribers

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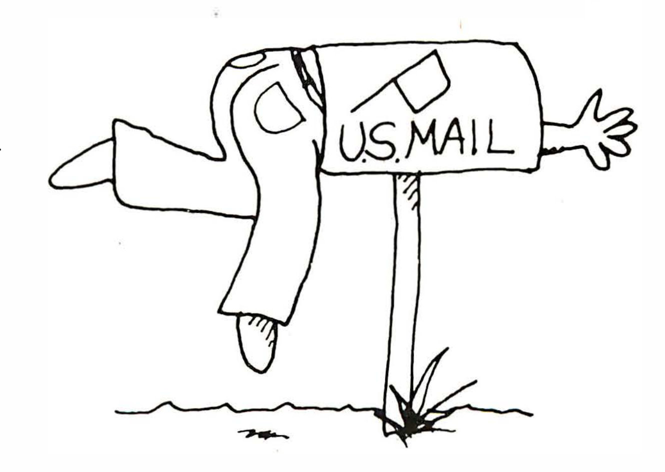
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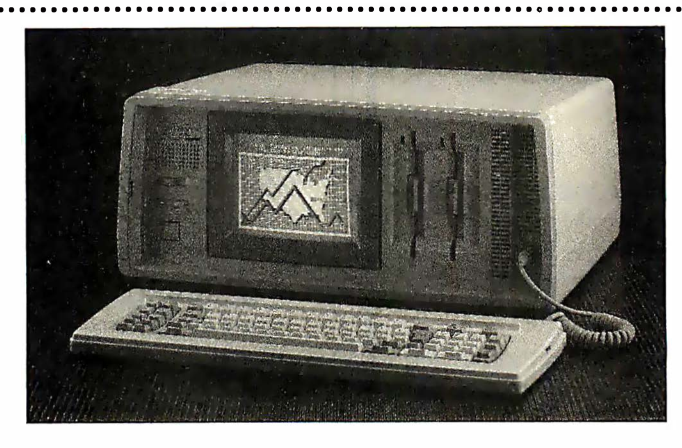


NEW SYSTEMS

Sanyo Introduces MBC 775

Sanyo's MBC 775 is an IBM PC-compatible portable color computer. It features the 8088 processor and provides for the 8087 chip. Its 256K-byte RAM is expandable to 640K bytes. Also standard are two 5¼-inch 360K-byte floppy-disk drives and a built-in 9-inch color monitor.

The MBC 775's detachable keyboard has 84 keys, including a numeric keypad and special-function keys. Two expansion slots will accept IBM PC-compatible add-on boards, and a Centronics parallel port lets the operator connect the color computer to most printers.



The Sanyo's screen accommodates 80 by 25 characters in regular mode and 40 by 25 characters in double-sized mode. The machine has 16-color graphics capabilities with 640- by 200-pixel resolution in color mode. In black-and-white mode, resolution is 320 by 200 pixels.

Bundled software for the MBC 775 includes EasyWriter 2, EasyMailer, EasyPlanner, and EasyFiler. Its operating system is MS-DOS 2.11, and it also features GW-BASIC.

Among several available options are an RS-232C serial board, an expansion RAM board, a Sanyo monochrome monitor CRT 30/CRT 36, the Sanyo color monitor CRT 70, and the Sanyo PR 5000 and PR 5500 letter-quality printers.

The MBC 775 retails for $2599. Contact Sanyo Business Systems Corp., 51 Joseph St., POB 387, Moonachie, NJ 07074-1098, (201) 440-9300.
Inquiry **513**.

Ergo-Intelligent Personal Computers

Ericsson Information Systems has introduced a series of IBM PC-compatible personal computers that offers ergonomic features. For example, the operator can mount the system console vertically beneath a desk, and a special cooling fan reduces the noise level.

The Ergo-Intelligent series comes with a 12-inch monochrome or color Ergo-Screen monitor. The non-glare monochrome display has amber characters and 640- by 400-pixel resolution. The color monitor has a maximum resolution of 320 by 200. The monitors can display text and graphics simultaneously; they use a modified typeface to improve clarity. An Ergo-Arm display stand lets you control the monitor's height and angle.

The Ergo-Touch keyboard uses 84 enlarged alphanumeric keys in the IBM PC XT layout. It has 10 function keys and indicator lights for the Num Lock and Caps Lock keys. The numeric keypad has its own Enter key.

The Ergo-Intelligent computer uses the 8088 processor, has 256K bytes of RAM, and provides for use of the 8087 math coprocessor. It features two 360K-byte floppy-disk drives or one floppy drive and a 10-megabyte hard-disk drive. Other hardware features include five IBM bus-compatible expansion slots, one RS-232C serial port, and one Centronics parallel port.

Prices depend on configuration. The basic model, designated the 8512-254S, comes with a dual disk drive, 256K bytes of RAM, monochrome monitor, graphics board, Ergo-Arm, floor stand, extended cable, keyboard, and DOS. It costs $3295; with a color monitor it's $3769. A system with a single floppy-disk drive and a 10-megabyte hard-disk drive sells for $5230; that system with a color monitor is $5695. Contact Ericsson Information Systems, Greenwich Office Park 1, POB 2522, Greenwich, CT 06836-2522, (203) 661-1666.
Inquiry **514**.

Multiuser UNIX Workstation

Heurikon Corporation has introduced the Minibox, a multiuser UNIX System III or V workstation that uses the 68000/68010 processor. It features a built-in C compiler, six Multibus card slots, single or dual 5¼-inch floppy-disk drives, 30- to 280-megabyte Winchester hard-disk storage, and an interactive streaming-tape drive.

The Minibox is based on the Heurikon HK68 microcomputer, providing 8- or 10-MHz processor performance, quad-channel DMA, 64K bytes of EPROM, 512K bytes to 1 megabyte of RAM, two iSBX expansion connectors, MMU (addresses 16 megabytes of RAM), four serial I/O ports (expandable to 12), three 16-bit counter timers, and two parallel I/O ports.

Two forward drive bays hold one or two 5¼-inch floppy-disk drives or a 5¼-inch floppy drive and an interactive streaming-tape drive. Two rear drive bays hold one or two 5¼-inch Winchester hard-disk drives.

Prices vary depending on configuration. A standard system with 512K bytes of RAM on a single card and a 30-megabyte hard-disk drive sells for $14,675; the same system with a 65-megabyte hard-disk drive is $15,375. Contact Heurikon Corp., 3201 Latham Dr., Madison, WI 53713, (800) 356-9602; in Wisconsin, (608) 271-8700.
Inquiry **515**.

NEW SYSTEMS

The S-100+ Outboard Bus

S-100+ from IMS International combines a high-speed, outboard, networking bus with the standard S-100 bus. The bidirectional outboard bus lets data transfer occur on a priority basis using byte-wide high-speed transfer components.

S-100+ eliminates bus contention problems. Simultaneous data transfer can be made from the master processor to the storage device and to the network slaves. A two-wire cable, daisy-chained from the master to the slaves, allows equal access to the bus through priority interrupts.

This design uses the following new circuit boards: a 16-bit 80186 8-MHz master board with one or two 512K-byte RAM boards, 80186 slave boards with 256K bytes of on-board RAM, and 8-bit Z80B 6-MHz master/slave boards with 128K bytes of on-board bank-switchable RAM.

The operating system for the S-100+, TurboDOS 1.40+, contains a PC-DOS/MS-DOS 1.1 emulator and allows a DMA transfer of data at up to 1 megabyte per second. All S-100+ boards are designed for both asynchronous and synchronous communications, and 3270 and 3780 communications software has been integrated into all models.

A basic S-100+ system, the 5000SX, has the potential for up to nine users and features TurboDOS, a Z80B file server, two serial ports, a paddleboard, a DMA floppy-disk drive controller, 128K bytes of RAM, four MPU 8-bit boards, one quad-density floppy-disk drive, and a 20-megabyte Winchester hard-disk drive. The 5000SX sells for $8195. For further information, contact IMS International, Division of L/F Technologies, 2800 Lockheed Way, Carson City, NV 89701, (702) 883-7611.
Inquiry **516**.

PERIPHERALS

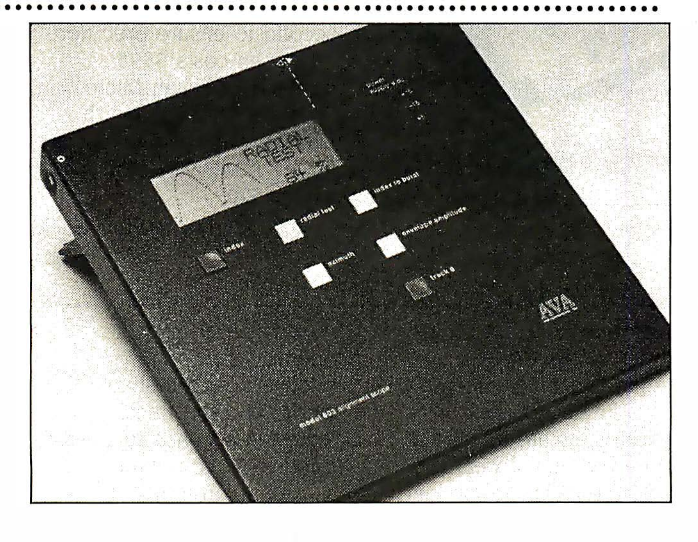
Doctoring Disk Drives

The Model 803 Alignment Scope uses liquid-crystal graphics-display technology to combine the features of an oscilloscope with a digital readout. It presents disk-drive alignment information on a solid-state display.

A wall-mount transformer powers the Model 803, which uses an 8085 microprocessor. The device works with all sizes of floppy disks and is self-calibrating.

The Model 803 has only six push buttons. It measures and displays all parameters necessary for alignment of a floppy-disk drive, including index pulse parameters, radial alignment (cat's-eye pattern), azimuth bursts, track average amplitude, index to burst time, and track 0 adjustment. The scope presents all measurements both pictorially and digitally.

The Model 803 Alignment Scope is $1195. For more information, contact Ava Instrumentation Inc., 8010 Highway 9, Ben Lomond, CA 95005, (408) 336-2281.
Inquiry **517**.



IBM PC AT Disk Drives for the PC and XT

A hardware and software package puts 1.2-megabyte IBM PC AT-compatible disk drives in the IBM PC and XT. The AT-compatible disks cut down on storage problems, eliminate disk swapping and disk-full errors, and let you back up a hard disk to only a few floppy disks.

The AT disk-drive package includes a Teac 1.2-megabyte half-height drive; a Teac 360K-byte half-height drive; a disk controller that supports up to four drives; a mounting bracket; and software to format, read, and write to 1.2-megabyte drives.

The basic two-drive package sells for $499. Contact Tall Tree Systems, Suite 124, 1032 Elwell Court, Palo Alto, CA 94303, (415) 964-1980.
Inquiry **518**.

Power Strip Series

The Voltector Series 10 conditioned power strip protects computer equipment from power surges and high-frequency AC-line noise. Each receptacle is RF-isolated from the others and from the power line.

This power strip eliminates the need to plug pieces of equipment into separate outlets or to install a separate circuit for your computer. The unit is a solid-state, multistage, bidirectional, cooperative transient-voltage suppressor and high-frequency EMI/RFI noise filter. All models are circuit-breaker protected. They include a pilot light, master on/off switch, and 6-foot, heavy-duty, three-conductor line cord. They are rated 15 amps, 125 volts, 60 Hz, and 1875 watts continuous duty.

Four-outlet models cost $146.40, six-outlet models are $152.90, and eight-outlet models are $159.40. Contact Pilgrim Electric Co., 29 Cain Dr., Plainview, NY 11803, (516) 420-8989.
Inquiry **519**.

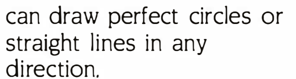
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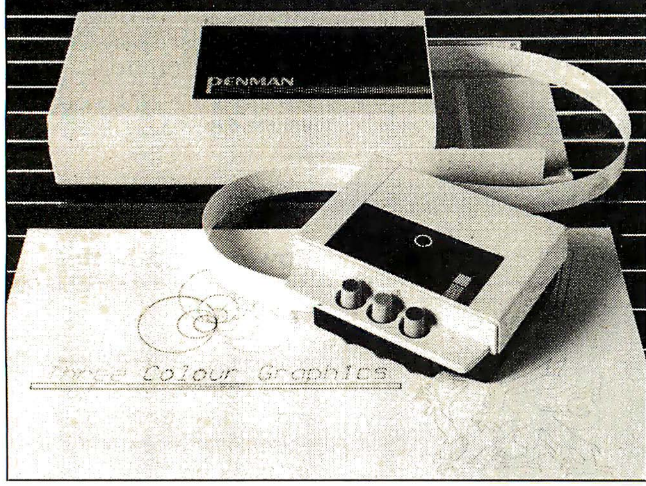
PERIPHERALS

Penman Robot Plotter

Penman is several peripherals in one: a three-color plotter, a high-resolution printer, a desktop turtle, a precision robot with collision detection, and a mouse. Penman connects to computers with an RS-232C interface. It has no controls; it automatically adjusts to its host computer.

The unit comprises two parts linked by a ribbon cable: the control box containing the electronics and a 5-inch-square robot that moves around on paper to produce graphics. Three built-in pen holders let the operator change pen color or thickness at any time, even in mid-line. Penman can draw perfect circles or straight lines in any direction.





To use Penman, you place any size of paper on a flat, horizontal surface. When the robot is set on the paper, it uses optical sensors to find the bottom left corner, which it uses as a point of reference. The robot also senses when the cable is twisted around it and automatically rotates to free itself.

The Penman robot moves at speeds up to 50 mm per second and achieves its accuracy by servo control of the drive motors. An 8-bit single-chip microcomputer performs the necessary calculations 1500 times per second to ensure precision.

Penman costs $395. Contact American Micro Products Inc., 705 North Bowser, Richardson, TX 75081, (214) 238-1815. Inquiry **520**.

High-Speed Daisy Wheel

Primages' daisy-wheel printing system comprises the Primage 90 bidirectional printer and a choice of Pagemate sheet-feeder options. The Primage 90 performs at 90 cps and prints proportional, 10, 12, and 15 pitch. It also offers horizontal spacing in increments of $\frac{1}{120}$ of an inch and vertical spacing at $\frac{1}{96}$ of an inch.

The Primage 90's design innovations incorporate 10 patents for stepper-motor controller technology, use of a Teflon-coated lead screw to carry the daisy wheel, and sheet feeders with short, straight paper paths to avoid skewing.

Other featured technology includes "print in flight" (the printer does not have to start and stop the print head for each letter), a refined hammer assembly, and enhanced electronics. The results are increased speed, reduced wear, improved registration, and less noise than previous printers.

The Pagemate sheet feeders come in one-, two-, or three-bin models. Paper bins hold 150 to 200 sheets of 8½- by 11-inch paper loaded horizontally or vertically; another bin holds 30 envelopes. The sheet feeders are motor-driven (not friction-driven), with one motor to choose sheet A or B and a second motor to drive the envelope and eject the paper.

The Primage 90 printer is also available with a snap-on tractor feeder, and the operator can install or remove both the sheet feeder and the tractor feeder in seconds to permit printing on computer forms as well as on individual sheets.

The Primage printing system features RS-232C and Centronics interfaces. The Primage 90 printer with the Pagemate I single-sheet feeder sells for $1895; with the Pagemate II two-sheet feeder it costs $2095; and with the Pagemate III two-sheet plus envelope feeder the price of the printer is $2295.

For further information, contact Primages Inc., 620 Johnson Ave., Bohemia, NY 11716, (516) 567-8200. Inquiry **521**.

Letter Quality with Dot-Matrix Versatility

Micro Peripherals' SX printer is a low-cost, letter-quality dot-matrix printer. It prints at 300 cps in draft mode, 71 cps in near letter-quality mode, and 52 cps in letter-quality mode. This printer also provides correspondence-quality documents.

The SX uses a 23- by 18-dot matrix to produce letter-quality print. In that mode, the printer can generate fonts with dot elements that overlap horizontally, vertically, and diagonally within the matrix.

In its IBM PC-compatible mode, it responds to IBM PC command sequences and prints the expanded character set. You use the SoftSwitch Keypad to switch from IBM to MPI operating mode and back. The SideWinder mode prints wide-column spreadsheets lengthwise on the paper. The SX prints the data at 12 cpi using a special font for sideways printing. (This feature requires MPI's 64K-byte buffer.) In Repeat mode, the printer receives the entire document and prints it up to 99 times.

The 18-key SoftSwitch Keypad lets you change the printer parameters without using software commands or changing DIP-switch settings. Accessible features include character densities, margins, form length, print quality, and modes.

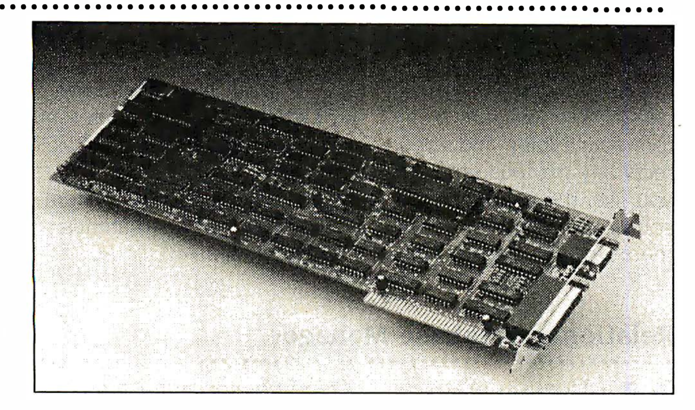
The SX has 8 standard fonts and can access Style-Writer, a library of more than 40 additional fonts. A travel cover ($50) converts the SX to a portable printer. The SX is $795. Contact Micro Peripherals Inc., 4426 South Century Dr., Salt Lake City, UT 84123, (800) 821-8848; in Utah, (801) 263-3081. Inquiry **522**.

ADD-INS

IBM PC Preview!

A monochrome display adapter for the IBM PC, PC XT, and PC AT is now available from AST Research. Preview! offers bit-mapped graphics compatible with popular business software packages.

The board occupies a single full chassis slot and has an IBM PC-compatible parallel-printer port. Preview! includes AST's SuperDrive RAM-disk simulator and SuperSpool print-spooler utilities to speed graphics file manipulation and graphics image printing.



AST has priced the Preview! board at $399. Contact AST Research Inc., 2121 Alton Ave., Irvine, CA 92714, (714) 863-1333.
Inquiry **523**.

Expanding the IBM PC AT

STB Systems recently released a memory-expansion board, Grande Byte, and a multifunction board, Rio Grande, for the IBM PC AT. Each 128K-byte board occupies one expansion slot.

Grande Byte gives AT users the additional memory necessary for multitasking programs or multiuser systems. The board provides extra memory for RAM disks and for handling large amounts of data. Parity-checked memory from 128K bytes to 2 megabytes is user-expandable with 64K- or 256K-byte memory chips. The board features split memory addressing that fills the AT's system memory to 640K bytes and continues memory expansion at 1 megabyte.

Rio Grande includes I/O expansion as well as memory expansion. Memory is user-expandable from 128K bytes to 1.5 megabytes with 64K- or 256K-byte chips. This board also uses split memory addressing. Rio Grande offers two IBM-compatible serial ports (one standard and one optional) for attaching a modem, serial printer, plotter, mouse, or other asynchronous communication devices. Its parallel port is a standard feature for connecting printers to the AT. An optional game port provides for graphics and recreation.

The Grande Byte is available for $395, and the Rio Grande sells for $495. Contact STB Systems Inc., Suite 125, 601 North Glenville, Richardson, TX 75081, (214) 234-8750.
Inquiry **524**.

Electrohome Introduces NAPLPS Decoder

A peripheral card for on-board decoding of NAPLPS information is available from Electrohome Electronics. The IBM PC-compatible Quickpel is a single-board decoder with multitasking capabilities including telesoftware.

Quickpel conforms to the Service Reference Model (SRM) in its use of macros, a dynamically redefinable character set, full color mapping, logical pel, and unprotected fields. Features that exceed SRM requirements include complete text scaling, splines, automatic clipping on screen boundaries, 6K-byte dynamic memory that can be shared between macros, textures, and object memory management.

Display resolution is 256 by 200 pixels and the status line is 256 by 10 pixels. Quickpel provides a choice of 16 simultaneous colors from its 512-color palette. The board plugs into a single IBM PC slot and drives a color monitor directly or a standard TV through an optional RF modulator.

The manufacturer expects Quickpel to sell for approximately $750. Contact Electrohome Electronics Ltd., 809 Wellington St. N, Kitchener, Ontario N2G 4J6, Canada, (519) 744-7111.
Inquiry **525**.

68000 Support for the IBM PC XT or AT

Language Resources offers an upgrade product, PC-68K, that supports 68000 family software development on the IBM PC XT or AT. The PC-68K comprises an IBM PC-compatible plug-in board, software on disks, and documentation.

The board, which acts as a 68000 execution vehicle, contains a 68000 processor, 256K bytes of high-speed RAM, and a memory-management subsystem. The disks contain the development tools: a 68000 macro assembler, a linker and locator, and a symbolic debugger. The symbolic debugger is for assembly-language and high-level language modules.

Optional Pascal and C compilers provide separate translation of C, Pascal, and MASM (meta assembler) modules. A host communication utility transfers binary and text files between the PC XT or AT equipped with PC-68K and an IBM VM-CMS, DEC, or VAX/VMS system running Language Resources' XDS-68 cross-software. Then you can download programs developed on the large system to the XT. With the emulator communication utility, you can connect several 68000 emulators to a PC XT or AT for integration.

The standard PC-68K system costs $2995. The high-level language compilers are $895 each. The host and emulator communication utilities cost $495 each. Contact Language Resources Inc., 4885 Riverbend Rd., Boulder, CO 80301, (303) 449-8087.
Inquiry **526**.

(continued)

SOFTWARE • APPLE

A-One, A-Two . . .

Anyone with a basic knowledge of music notation can use the MusiCal Music Partwriting System (MPS) to create, edit, transpose, store, and print full-size sheet music. This program, which runs on an Apple II+ or IIe with two disk drives, a monitor, and a Super Serial Card, is designed to eliminate the tedious task of copying and transposing parts by hand. You don't have to learn any special commands or programming languages nor do you have to be able to play an instrument. MPS can create sheet music in any key or time signature, with proper beaming of notes, ties, triplets, and rests.

The Music Screenwriter, the system's intelligent editor, lets you input and delete music in the same way you input and delete characters with a word processor. The program monitors your typing and corrects any obvious errors. If you like, the computer will sound the notes as you type them. Any music you write can be stored on the program disk; later, you can print it out in original form or transpose it to a different key. An average sheet of music takes about 10 minutes to print; the system uses Houston Instrument's DMP-29, DMP-40, or PC digital plotters.

The price of $1495 gets you the software, key caps, plotter cable, and the $695 PC 695 plotter. Contact Newgo Inc., POB 430, Stephens City, VA 22655, (703) 869-1600.
Inquiry 527.

Relational Database Manager

MacLion is a relational database-management system for the Macintosh. Because MacLion is a true relational system, there is no limit to the number, range, or variety of data that may appear on the screen. Many relations can be combined to suit the user's need.

The program facilitates the handling of files and relations with two features: a report writer and a screen generator. The user can define a report or screen by clicking fields into position with the Mac's mouse, thus getting a preview of the screen or report. The screen generator has multifile capabilities for both inputting data into and drawing data from the database.

Features implementing the Mac's desktop metaphor have been incorporated in the language of MacLion. Applications developed under MacLion can use the Mac's mouse, pull-down menus, dialogue boxes, and programmable buttons.

MacLion costs $379. Contact Computer Software Design, 1911 Wright Circle, Anaheim, CA 92806, (714) 634-9012.
Inquiry 528.

Integrated Mac Pack

TimeBase, a business tool for the Macintosh, makes use of an overlapping windowed environment to provide five applications on a single disk: time management, information management, centralization, forms and letters, and a feature called TMP (tracking, maintaining, and planning). Virtually all commands and functions are generated with the mouse; the only time you need the keyboard is for data entry.

For those situations not requiring a stand-alone database, the program provides a fixed-field, limited database known as the File Cabinet, capable of storing up to 100 records. The File Cabinet has complete search and print capabilities.

Business forms and letters created with the package can be transferred to MacPaint for editing and customizing. TMP, the heart of this interactive system, lets you track multiple schedules, information flow, accounts payable and receivable, and equipment maintenance. The program can also handle records, billing cycles, and timely mailings.

TimeBase is available for both the 128K- and the 512K-byte Macintosh and will run on the Lisa under MacWorks. The suggested retail price is $149.95. Contact SoftDesign, POB 161377, Miami, FL 33116, (305) 253-5521.
Inquiry 529.

Business Software for IIc, IIe

The Business Accountant is a double-entry business accounting system that includes p ograms for general ledger, accounts payable and receivable, inventory, and pay oll. These programs can be used together or separately and are designed for small and medium-sized businesses.

General Ledger lets you define the way a chart of accounts is set up and the manner by which data should be consolidated. Out-of-balance journal entries are not permitted. Accounts Payable can produce checks automatically; Accounts Receivable lets you review a customer's credit status at any time. Inventory Control tracks all inventory parts and produces reports for order recommendations.

The Business Accountant's Payroll system handles hourly, salaried, and commissioned employees on a weekly, biweekly, semimonthly, or monthly basis. The system also produces W-2 and W-3 forms and 940 and 941 reports and can handle up to 14 types of deductions. The System Manager is necessary to integrate any of the modules and includes a mailing-label system that can access the other modules for names and addresses.

The System Manager is $95. The Payroll package costs $345. The other modules are $295 each. Contact Manzanita Software Systems, Suite 200-A, One Sierra Gate Plaza, Roseville, CA 95678, (916) 781-3880.
Inquiry 530.

SOFTWARE • IBM PC

Database with Analysis

Designed to aid managers, researchers, and planners in the collection and interpretation of data, Reflex is a database software package that combines information management with analysis features. Information can be grouped and summarized in ways that reveal interrelationships, trends, and deviations.

Data can be organized in lists and tables, selectively extracted and displayed in charts and graphs, and summarized or combined using built-in financial, statistical, and mathematical functions. You can shift quickly between formats, or "views," and move from a detailed look at a particular record to a summation of information from many records.

Reflex has pull-down menus, screen windows, and help screens that can be accessed with one keystroke. It can hold up to 64,000 records on disk and more than 7000 records in its working database. Because the entire program and the data being worked on are stored in RAM, the system does not have to continually load and reload portions of the program from disk.

Reflex can accept information from several popular business packages, including dBASE II, Lotus 1-2-3, and DIF, as well as ASCII text files downloaded from mainframes and minicomputers or transferred from other microcomputers.

The package runs on the IBM PC and compatibles and requires 384K bytes of RAM and graphics capability. The suggested retail price is $495. For more information, contact Analytica Corp., 3155 Kearney St., Fremont, CA 94538, (415) 490-3643.

Inquiry 531.

APL Programming Package

Pocket APL, an APL programming package for the IBM PC, PCjr, and compatibles, is designed to save development time by enabling users to execute multiple tasks in a single line. According to the vendor, the product lets you develop applications 4 to 10 times faster than with languages like BASIC or FORTRAN.

Features include full-screen capabilities, an on-line help facility, English-like keywords, report formatting, and error trapping. Additionally, Pocket APL can serve as an on-line calculator for number crunching and analysis. The package also provides an APL software character set for computers with a graphics board or color monitor; for machines with monochrome monitors there's a set of keywords.

STSC's Pocket APL has many of the capabilities of the company's APL*Plus. Purchasers of Pocket APL can upgrade to APL*Plus.

The program, which comes on one disk, operates with a minimum of 128K bytes of memory and either PC-DOS or MS-DOS. The system includes a textbook, reference guide, and keyword reference card. Contact STSC Inc., 2115 East Jefferson St., Rockville, MD 20852, (800) 592-0050; in Maryland, (301) 984-5123.

Inquiry 532.

UNIX-Compatible Tool Kit

Lantech Systems has released a software developer's tool kit that's designed to enable an IBM PC to be used as a workstation in mainframe, minicomputer, and microcomputer environments. Retailing for $399, the Tool Kit contains a terminal emulator, windowing capability, and a choice of text editors (the Bell Editor, vi Editor, ed Editor, or an EMACS-like editor called Epsilon).

The Tool Kit also includes uNETix, a UNIX-compatible multitasking operating system developed by Lantech.

Developers can use the editor to write applications off line from the larger system, which frees up processor cycles. Once the code has been generated, it can either be uploaded to the larger computer for compilation or it can be compiled on the PC.

The Tool Kit can be operated in stand-alone mode or in conjunction with a host system.

The Lattice C-Compiler is offered as an option. With the compiler, the user can develop applications in a local mode, which eliminates the need for a UNIX host machine.

For more information, contact Lantech Systems Inc., 9635 Wendell Rd., Dallas, TX 75243, (214) 340-4932.

Inquiry 533.

Text-Composition System

ScenicWriter/HP is a text-composition system that enables the IBM PC and PC XT to operate with Hewlett-Packard's LaserJet printer. ScenicWriter uses all of the laser printer's font cartridges, built-in fonts, and symbols. Graphics such as frames, screens, and simulated cursors can be placed anywhere on a page. Output from the printer is said to be camera-ready for publication.

With ScenicWriter, you can number chapter headings, sections, footnotes, and illustrations in order as each document is printed. The full-screen editor features nested editing, global search and replace, block copying, and a macro system. Any sequence of formatting commands can be collected into a macro command.

ScenicWriter sets text on the page in single- or multiple-column format. Dimensions can be specified to fit a page design. The package includes a 40,000-word spelling checker that accepts unlimited additions.

ScenicWriter is also available for PC-compatibles, Stride Micro computers, and versions are slated for the TI Professional and the DEC LSI/PDP series. The program is also available for other laser printers, phototypesetters, and daisy-wheel printers. The LaserJet version costs $995. Contact Scenic Computer Systems Corp., 14852 Northeast 31st Circle, Redmond, WA 98052, (206) 885-5500.

Inquiry 534.

(continued)

SOFTWARE • CP/M/MS-DOS

Files Protected

Once a file is protected by For Your Eyes Only, Grebar claims, no one will be able to access it without the correct password. The program protects files created by any software running under MS-DOS, including dBASE II and dBASE III, VisiCalc, WordStar, Framework, RBase, and Lotus 1-2-3 files.

Grebar's data-encryption algorithm alters every byte of a file; the company says no utility can bypass this security measure. The algorithm employs a 560-bit encrypting code. According to Grebar, it would take a thousand Cray-1 supercomputers more than 4 billion years to generate all possible code combinations.

For Your Eyes Only can protect files on floppy or hard disks. You can re-encrypt a file up to 99 times with one run of the program and protect more than 100 files with the same password in a single operation.

Protected files are automatically hidden and do not appear in a normal directory listing. Only you know where they are stored.

You must enter an access code before an encrypted program will run, and illegal attempts to use the program or break into a file are recorded in a log that's accessible only to authorized users.

Minimum requirements are an IBM PC or Compaq with 192K bytes of RAM, one single-sided disk drive, and DOS 2.0 or later. For Your Eyes Only costs $150 (U.S.). For more information, contact Grebar, 2926-266 Graham Ave., Winnipeg, Manitoba R3C 4B5, Canada.
Inquiry 535.

FORTH Interpreter

A FORTH interpreter optimized for MS-DOS and IBM PC machines, HS/FORTH includes utility files to read, write, and load standard MS-DOS files, standard screens, and screens mapped onto random-access files. Other utilities are segment management, graphics, string functions, a program editor, and 8087 floating-point arithmetic.

The assembler, which implements the complete 8088/8086 instruction set, can create new code primitives or complete stand-alone program files.

Users unfamiliar with assembly language can take advantage of an Auto-Opt utility to generate optimized machine code from FORTH source code. The assembler also supports 8087 and 80186 microprocessors.

According to the company, HS/FORTH can run the Sieve of Eratosthenes benchmark in 47 seconds. With Auto-Opt, the benchmark reportedly takes 9 seconds.

HS/FORTH requires 64K bytes, one disk drive, and PC-DOS or MS-DOS. The price is $250. Contact Harvard Softworks, POB 2579, Springfield, OH 45501, (513) 390-2087.
Inquiry 536.

Disk Recovers Lost Data

A set of disk media utilities, U.T. Disk can restore deleted files on floppy disks and internal and external hard-disk subsystems. The product supports 64 DOS volumes. Clusters of an erased file assigned to another file can be restored unless the user has physically written over every byte of the original data.

In addition to restoring lost data, U.T. Disk provides diagnostic checking, sector editing, raw sector data searching, and file and subdirectory editing. Its Custom Volume Configuration feature lets a programmer change certain fixed attributes of a DOS volume, including the number of root entries or reserved sectors.

U.T. Disk is written in C and is menu-driven. It sells for $99. Contact Great Lakes Computer Peripherals Inc., Suite 245, 2200 West Higgins Rd., Hoffman Estates, IL 60195, (312) 884-7272.
Inquiry 537.

MS-DOS Information Management

With RMI Profiler, an information-management system, you can "draw" input formats and report structures on the screen using standard keyboard entries. RMI Profiler accepts up to 80 fields and 2000 characters per record. It requires at least 128K bytes of memory. The price is $795 (Canadian). Contact Reality MicroSystems Inc., Suite 203, 103 Lakeshore Rd., St. Catharines, Ontario L2N 2T6, Canada, (416) 935-3032.
Inquiry 538.

WHERE DO NEW PRODUCT ITEMS COME FROM?
The new products listed in this section of BYTE are culled from the thousands of press releases, letters, and telephone calls we receive each month from manufacturers, distributors, designers, and readers. The basic criteria for selection for publication are: (a) does a product match our readers' interests? and (b) is it new or is it simply a reintroduction of an old item? Because of the volume of submissions we must sort through every month, the items we publish are based on vendors' statements and are not individually verified. If you want your product to be considered for publication (at no charge), send full information about it, including its price and an address and telephone number where a reader can get further information, to New Products Editor, BYTE, POB 372, Hancock, NH 03449.

Free-Form Retrieval

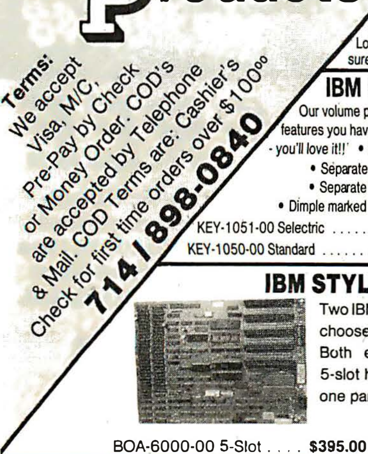
You can retrieve all sentences or paragraphs relating to a specific topic, no matter how many files the topic is in, with a program called Electra-Find. The package, which runs on CP/M computers, is designed for writers, researchers, and anyone who uses a word processor to save information in text format.

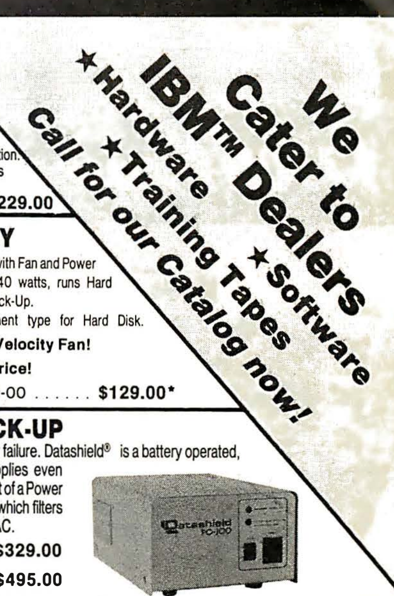
After you've retrieved material, it's saved in a new file along with the name of the file the text was taken from. According to the developer, nearly any type of file can be searched, including database, word-processing, and binary files.

Electra-Find costs $50. Contact O'Neill Software, POB 26111, San Francisco, CA 94126, (415) 398-2255.
Inquiry 539.

Micro Products

New Year Specials





New Hayes SmartModem Compatible!

Finally a **price breakthrough** on a Hayes compatible, external 300/1200 baud modem. This low price is without driver software, but if you need it add **$25.00** Call for a 26 page catalog of our special deals. Look in this spot every month for Hot, New items sure to catch your interest.



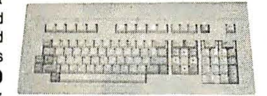
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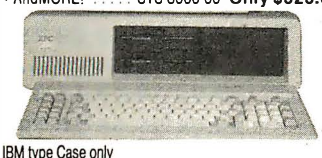
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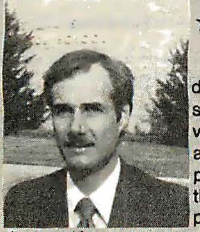
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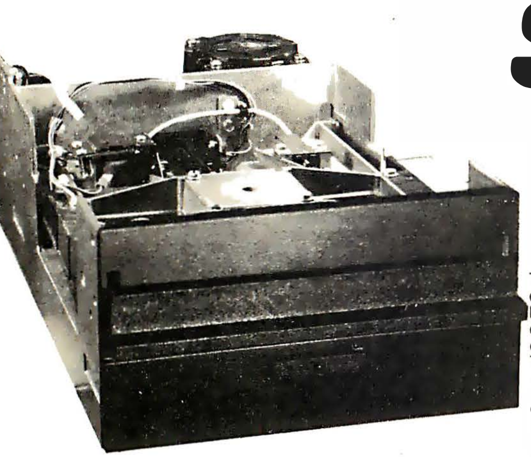
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Add-On Memory, RAM Disk & Print Spooler BOA-8650-00 . . . . . **$149.00**
Color Graphics Card, 320 x 200 Res. Color, 640 x 200 Monochrome
BOA-8400-00 . . . . **$245.00**
Monochrome Graphics Card, (1-2-3 compatible) 720hx 348v
BOA-8500-00 . . . . **$155.00**
Clock Calendar Board, Parallel Port, fits in "short slot" w/battery Back-up
BOA-8700-00 . . . . **$75.00**
XOR-500 Printer, Dot Matrix, 80 col., IBM Graphics compatible
PRI-5575-00 . . . . **$495.00**
Monochrome Monitor, 18MHz bandwidth, composite input Green Screen
MON-1000-00 Green . . . . **$ 99.50**
MON-1010-00Amber **$114.50**
Floppy Controller, Controls up to fourdrives, 5¼" 48/96 TPI
BOA-6100-00 . . . . **$95.00**
Hard Disk Controller, standard ST-506 interface for DOS 1.1 & 2.0
BOA-8050-00 . . . . **$245.00**

Inquiry 231

► **Micro Products • 15392 Assembly Lane • Huntington Beach, CA 92649 • 714/898-0840** ◄

California Digital

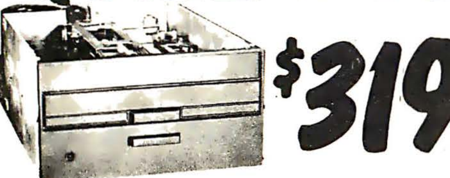
17700 Figueroa Street • Carson, California 90248



Shugart $159

The Shugart 801R has long been the standard by which all other eight inch disk drives have been judged. The 801R has historically been used by thousands of quality conscious equipment manufacturers because of their extremely high degree of reliability.
These units are current production, rack mountable LSI technology. The drives are identical to drives currently sold by distributors at $600.
California Digital has aquired these NEW units as a result of a change of marketing strategy of the A.M. Jaquard Corporation. This is the best value that has ever been offered on any Shugart eight inch disk drive. SHU-801R

QUME DT8 $319



These Qume DT8/842 disk drives are NEW double sided units acquired from the excess inventory of a major computer manufacturer.

Five Inch Winchester Hard Disk Drives

	One	Two
FUJITSU M2235AS 27 Meg.	999	959
RODINE RO-208 53 Meg.	1589	1493
MAXTOR XT1065 65 Meg.	1995	1965
SHUGART 712 13 Meg. ½ Ht	795	765
SHUGART 604 6.7 Meg.	159	149
TANDON 502 10 Meg.	419	395
TANDON 503 19 Meg.	795	775

Upon request, all drives are supplied with power connectors and manual

MEMORY



DYNAMIC MEMORY

		1-31	32 +	100 +
4116 150ns. 16K	ICM-4116	1.75	1.65	1.45
4116 200ns.16K	ICM-41162	1.75	1.65	1.45
4164 150ns.64K 128 refresh	ICM-41641	3.95	3.40	3.25
41256150ns.256K	ICM-41256150	18.95	17.50	14.75
4228 for IBM/AT	ICM-4128150	18.95	17.50	14.75
DP8409 dynamic controller	ICT-8409	39.00	35.00	29.00

STATIC MEMORY

21L02200ns. 1K static	ICM-21L02200	1.49	1.29	1.15
21L02450ns. 1K static	ICM-21L02450	1.29	1.15	.99
2112 450ns.2K static	ICM-2112450	2.99	2.85	2.75
2114 300ns. 1K x 4	ICM-2114300	1.95	1.85	1.75
4044TMS 450ns. 4K x 1	ICM-4044450	3.49	3.25	2.99
5257300ns. 4K x 1	ICM-5257300	2.50	2.25	1.99
6116 P4200ns.2K x 8	ICM-6116200	3.95	3.85	3.70
6116 P3 150ns.2K x 8	ICM-6116150	4.55	4.35	4.15

EPROMS

2708 450ns. 1K x 8	ICE-2708	4.95	4.75	4.55
2716 450ns. 2K x 8	ICE-2716	4.50	4.25	3.97
2716TMS 450ns. Tri-voltage	ICE-2716TMS	7.95	7.65	7.25
2732 450ns. 4K x 8	ICE-2732	4.50	3.75	3.55
2764 350ns. 8K x 8	ICE-2764	5.95	5.75	6.25
27128 350ns. 16K x 8	ICE-27128	18.95	16.75	15.25



$129

Your Choice

TEAC 55B 55F
48TPI·96TPI

Five Inch Single Sided Drives

	One	Two	Ten
SHUGART SA400L full height	189	179	175
TANDON TM100-1 full height	99	95	79

Five Inch Double Sided Drives

TEAC FD55B half height	139	135	129
TEAC FD55F 96 TPI, half ht.	139	135	129
REMEX RFD480 ⅔ ht. IBM/PC	39	39	35
CONTROL DATA 9409 PC	169	159	155
CONTROL DATA 9428 ½ ht.	119	115	109
SHUGART SA455 Half Height	139	135	129
PANASONIC JA551/2N (455)	139	135	129
SHUGART SA465 ½ Ht. 96TPI	239	229	219
TANDON 100-2 full height	169	165	169
TANDON 101-4 96TPI full ht.	329	319	305
MITSUBISHI 4851 half height	159	149	145
MITSUBISHI 4853 96/TPI½ Ht.	169	159	155
MITSUBISHI 4854 8" elec.	395	385	375
QUME 142 half height	219	205	199

REMEX DOUBLE SIDED $219



Eight Inch Single Sided Drives

SHUGART 801R	159	159	154
SIEMENS FDD 100-8	129	125	119
TANDON 848E-1 Half Height	369	359	349

Eight Inch Double Sided Drives

SHUGART SA851R	495	485	475
QUME 842 "QUME TRACK 8"	319	319	313
TANDON 848E-2 Half Height	459	447	435
REMEX RFD-4000	219	219	209
MITSUBISHI M2894-63	447	439	433
MITSUBISHI M2896-63 ½ Ht.	459	449	409



FREE

Plastic library case supplied with all diskettes purchased from California Digital.

DISKETTES $16.50

FIVE INCH SINGLE SIDED DOUBLE DENSITY

	Soft Sector / Ten Sector / Sixteen	Each box	10 Boxes	100 Boxes
CAL DIGITAL	CAL.501 / CAL.510 / CAL.516	16.50	14.95	13.50
SCOTCH	MMM-744/0 / MMM-744/10 / MMM-744/16	22.95	21.75	20.75
VERBATIM	VRB-525/01 / VRB-525/10 / VRB-525/16	22.95	21.75	20.75
MEMOREX	MRX-3481 / MRX-3483 / MRX-3485	19.95	18.75	17.85
MAXELL	MXL-MD1 / MXL-MH1/10 / MXL-MH1/16	22.95	21.75	20.75
DYSAN	DYS-104/1D / DYS-107/1D / DYS-105/1D	32.25	31.00	29.75

FIVE INCH DOUBLE SIDED DOUBLE DENSITY

CAL DIGITAL	CAL.551 / CAL.561 / N/A	19.95	18.75	17.85
SCOTCH	MMM-745/0 / MMM-745/10 / MMM-745/16	29.95	27.95	24.75
VERBATIM	VRB-550/01 / VRB-550/10 / VRB-550/16	29.95	27.95	23.75
MEMOREX	MRX-3491 / MRX-3493 / MRX-3495	27.95	26.75	24.25
MAXELL	MXL-MD2 / MXL-MD2/10 / MXL-MD2/16	27.95	25.95	24.25
MAXELL / HD	MXL-MD2/96 / N/A / N/A	CALL		
DYSAN	DYS-104/2D / DYS-107/2D / DYS-105/2D	42.50	40.50	35.50
DYSAN / 96	DYS-204/2D / N/A / N/A	49.95	47.95	45.75

EIGHT INCH SINGLE SIDED SINGLE DENSITY

SCOTCH	MMM-740/0	28.50	27.50	23.80
MEMOREX	MRX-3062	27.75	26.60	22.25
VERBATIM	VRB-34/9000	31.50	29.50	25.60
DYSAN	DYS-3740/1	35.75	32.75	29.75

EIGHT INCH SINGLE SIDED DOUBLE DENSITY

SCOTCH	MMM-741/0	33.95	31.75	29.15
MEMOREX	MRX-3090	31.95	27.75	26.15
VERBATIM	VRB-34/8000	35.25	33.25	28.75
DYSAN	DYS-3740/1D	40.75	38.75	32.25
MAXELL	MXL-FD1	45.50	39.75	35.15

EIGHT INCH DOUBLE SIDED DOUBLE DENSITY

SCOTCH	MMM-743/0	45.95	43.25	37.50
MEMOREX	MRX-3102	37.95	36.75	31.50
VERBATIM	VRB-34/4001	41.75	37.50	32.25
DYSAN	DYS-3740/2D	54.65	49.75	40.50
MAXELL	MXL-FD2	52.50	48.75	40.45

ENCLOSURES

California Digital manufactures an asortment of stock and custom disk drive enclosures. If the volume is justified we will custom design an en closure for your application. The following stock disk drive enclosures are available. All include power supplies the 8" enclosures are supplied with exhaust fans.

- Horizontal mount dual 8" full height drives. $279.00
- Vertical mount dual full height 8" drives. 299.00
- Horizontal mount one full height or two half height 8". 239.00
- Horizontal one full height or two half height 5¼". 89.00



Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. • COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.



California Digital

17700 Figueroa Street • Carson, California 90248

NEC RGB COLOR MONITOR $259



The NEC JC-1401D is a 13" medium/high resolution RGB monitor suitable for use with the Sanyo MBC-550/555 or the IBM/PC. The monitor features a resolution of 400 dots by 240 lines. Colors available are Red, Green, Blue, Yellow, Cyan, Magenta, Black and White. These monitors are currently being used in applications far more critical than microcomputers.
The NEC monitor carries the Litton-Monroe label and was originally scheduled for use in their "Office of the Future" equipment. A change in Monroe's marketing strategy has made these units excess inventory which were sold to California Digital. We are offering these prime "new" RGB monitors at a fraction of their original cost. Sanyo compatible NEC-1401/S; IBM/P/C Computer compatible NEC-1401/PC

MONITORS

BMC 12A green phosphor 15 MHz composit video.	BMC-12A	7895
BMC 12" high resolution. 20MHz.	BMC-12EN	119.00
Amdek 300G 12" green phosphor	AMK-300G	128.95
Amdek 300A 12" amber phos., hi-resolution	AMK-300A	138.95
Amdek 310A designed for IBM/PC, amber	AMK-310A	15895
Zenith ZVM122 Amber Phosphor 12" 40/80 column switch.	ZTH-122	8995
Zenith ZVM123 green phosphor 12" 40/80 column switch	ZTH-Z123	8995
NEC JB1201 green phosphor 18 MHz composit video	NEC-JB1201	15900
NEC JB1260 commercial grade composit	NEC-JB1260	11900
Conrac 9" openframe requires horz sync & 12v supply	CON-BW9	5900

COLOR

NEC JC1401D Medium/High 13" RGB	NEC-1401/X	259.00
BMC AU9191U Color composit video with sound	BMC-9191	23895
BMC 9191M RGB designed for use with the IBM computer	BMC-9191M	37900
NEC JC1203DM. RGB color monitor	NEC-1203	69900
NEC JC1215 color composit	NEC-JC1215	339.00
Zenith ZVM 135 RGB & composite suitable for IBM PC	ZTH-Z135	47500
Amdek Color I 13" composit video	AMK-100	299.00
Amdek Color II +, 13" RGB hi/resolution	AMK-200	419.95
Amdek Color III +, 13" RGB, medium resolution	AMK-300	359.95
Princeton HX 12 RGB IBM/PC compatible	PRN-HX12	47895

PRINTERS

MATRIX PRINTERS

Star Gemini-10X 120 char/sec.	STR-G10X	259.0
Star Gemini-15X, 100 char./sec. 15" paper	STR-G15X	365.0
Star Gemini Delta 10, 160 Char/sec	STR-D10	399.0
Star Coex 80FT friction & tractor	VST-C80FT	179.
Toshiba P1351, 192 char/sec. letter quality	TOS-1351	1495.0
Okidata 82A serial & parallel 9½" paper	OKI-82A	329.0
Okidata 92A parallel interface, 160 char/sec	OKI-92A	399.0
Okidata 83A & parallel 15" paper	OKI-83A	559.0
Okidata 84A & parallel 15" paper	OKI-84A	9290
Epson RX-8010" 120 Char/sec	EPS-RX80	2590
Epson FX80, 10" 160 char/sec with graphtrax	EPS-FX80	439.00
Epson FX 100 15" 160 char/sec with graphtrax	EPS-FX100	629.0
Epson LQ1500 15" corespondence quality	EPS-LQ1500	1179.0
Epson JX80 Color printer	EPS-JX80	579.0
Anadex 9501B high speed with graphics	ADX-9501B	1029.0
Anadex 9620B 200 char/sec. parl & serial	ADX-9620B	1129.00
Prowriter 8510 parallel 9½" paper	PRO-8510P	35900
Prowriter II, parallel 15" paper, graphics	PRO-2P	689.00
Dataproducts B-600-3, band printer 600 LPM	DPS-B600	6985.00
Printronix P300 high speed printer 300 lines per minute	PTX-P300	3995.00
Printronix P600 ultra high speed 600 lines per minule	PTX-P600	5795.00

WORD PROCESSING PRINTERS

NEC7710 55 char/second, serial interface	NEC-7710	1795.00
NEC7730 55 char/sec, par'l interface	NEC-7730	1795.00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1599.00
NEC2050 designed for IBM/PC 20 char/sec par'l	NEC-2050	995.00
Silver Reed EXP500, 14 char/sec. par'l interface	SRD-EXP500	459.00
Silver Reed EXP550 17 Char/sec par'l interface	SRD-EXP550	659.00
Diablo 630 40 char/sec serial	DBL-630	1765.00
Diablo 620, proportional spacing, horz & vert tab 20cps	DBL-620	775.00
Juki 6100, 18 char/sec SPECIAL	JUK-6100	429.00
Brother HR1A serial interface	BTH-HR1S	695.00
Starwriter F10 serial, 40 char/sec	PRO-F10S	1125.00
Starwriter F10 parallel, 40 char/sec	PRO-F10P	1125.00
Comrex CR2, 5k buffer, proportional spacing, par'l	CRX-CR2P	495.00

TERMINALS

Freedom 100, split screen, detatchable keyboard	LIB-F100	495.00
Qume 102 green phosphor terminal	QUM-102	539.00
Ampex Dialogue 125 green screen,	APX-D125G	675.00
Ampex Dialouge 175 amber screen, two page, func. keys	APX-D175A	719.00
Wyse50, 14" greenphosphor	WYS-50	59500
Wyse 300, Eight color display, split screen,	WYS-300	1159.00
Zenith 29 terminal, VT52 compatible, detatchable keyboard	ZTH-Z29	765.00
Televideo 910 Plus, block mode	TVI-910P	575.00
Televideo 925, detatchable keyboard, 22 function keys	TVI-925	759.00
Televideo 950, graphic char., split screen, 22 func	TVI-950	950.00
Televideo 970, 14" green, 132 column, European	TVI-970	1095.00

TRIAL OFFER

1200 BAUD MODEM



$229

The Team 212A offers all the features of the Hayes Smart Modem 1200 for a fraction of the price. Now is your opportunity to purchase a 1200 baud modem at the price of a 300 baud modem.
California Digital is so confident of your complete satisfaction that we will allow the return the Team 212A and apply the full credit towards the purchase of any other 1200 baud modem. TEM-SM1200

MODEMS



$319

The CTS212AH Modem is 300/1200 Auto Answer/Auto Dial, Hayes Compatible. Mycroft Labs Companion communications software $35.00 additional

CTS 212AH 1200 baud, auto dial	CTS-212AH	319.00
Signalman Mark 12, 1200 baud, Hayes compatible	SGL-MK12	25900
Signalman Mark 1, direct connect with terminal cable	SGL-MK1	75.00
Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AD	479.00
Hayes 1200B for use with the IBM/PC, 1200 baud	HYS-1200B	429.00
Hayes Smartmodem, 300 baud only auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	27900
Hayes Chronograph, time & date	HYS-CHR232	199.00
Prometheus 1200 super features	PRM-P1200	359.00
Prometheus 1200B internal PC	PRM-P1200B	279.00
Team 1200 Hayes Compatible	TEM-SM1200	229.00
U.S. Robotics 212A 300/1200 baud, auto dial/answer.	USR-212A	439.00
U.S. Robotics Password 300/1200 baud	USR-PW212	389.00
Penril 300/1200 industrial quality	PEN-12AD	59500
Universal Data 103LP, line power, answer & originate	UDS-103LP	169.00
Universal Data 202, 1200 baud, half duplex only	UDS-202LP	219.00
Universal Data 212LP, full 1200 baud duplex, line power	UDS-212LP	359.00
Novation J Cat direct connect, auto answer	NOV-JCAT	115.00

IBM PC with Controller $1099



AST $219 SIX PAK PLUS

AST SixPackPlus		zero memory	$219.00
AST SixPackPlus	384K	fully populated board	399.00
AST MegaPlus II	64K	to 512K with MegaPak	265.00
AST MegaPak	256K	piggyback / MegaPlus	265.00
Quadboard	64K	with six functions	249.00
STB RIO Plus	64K	with PC accelerator	279.00
STB Super I/O		serial/par'l/game port	184.99

AST Monograph Plus	monochrome/graphic	449.79
Hercules Graphic	two year warranty	339.89
Hercules Color Card	new from Hercules	189.89
PC Peacock Color	mono. RGB. graphics	229.00
Quad Color I	expandable, high res.	209.75
STB Graphics Plus	with software	379.67

4164 Memory Chips	150 or 200 ns	3.95
64K Set (9 chips)	with instructions	34.95
8087 CoProcessor	arithmetic chip	119.00

OLYMPIA Computer Printer and Typewriter

As low As **$339**

The Olympia Corporation has just released two new typwriters with built in Centronics printer interface. These word processing printer are the ideal answer to your personal correspondence needs. The Compact 2 pictured above prints at 14 characters per second and is priced at $459 OLY-C2. The Orbit XP prints at 10 characters per second and is priced at only $339 OLY-XP1. Both machines are equiped with 2 K/byte printer buffers.

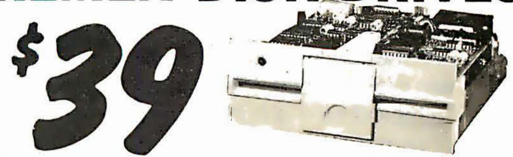
Shugart 604 WINCHESTER

$159

These 6.7 Megabyte drives are new units recently released by the Shugart division of Xerox.
The Shugart 604 is fully 506 industry compatible. Each drive is tested before shipment and is supplied with a 90 day warranty. SHU-604

DOUBLE SIDED REMEX DISK DRIVES

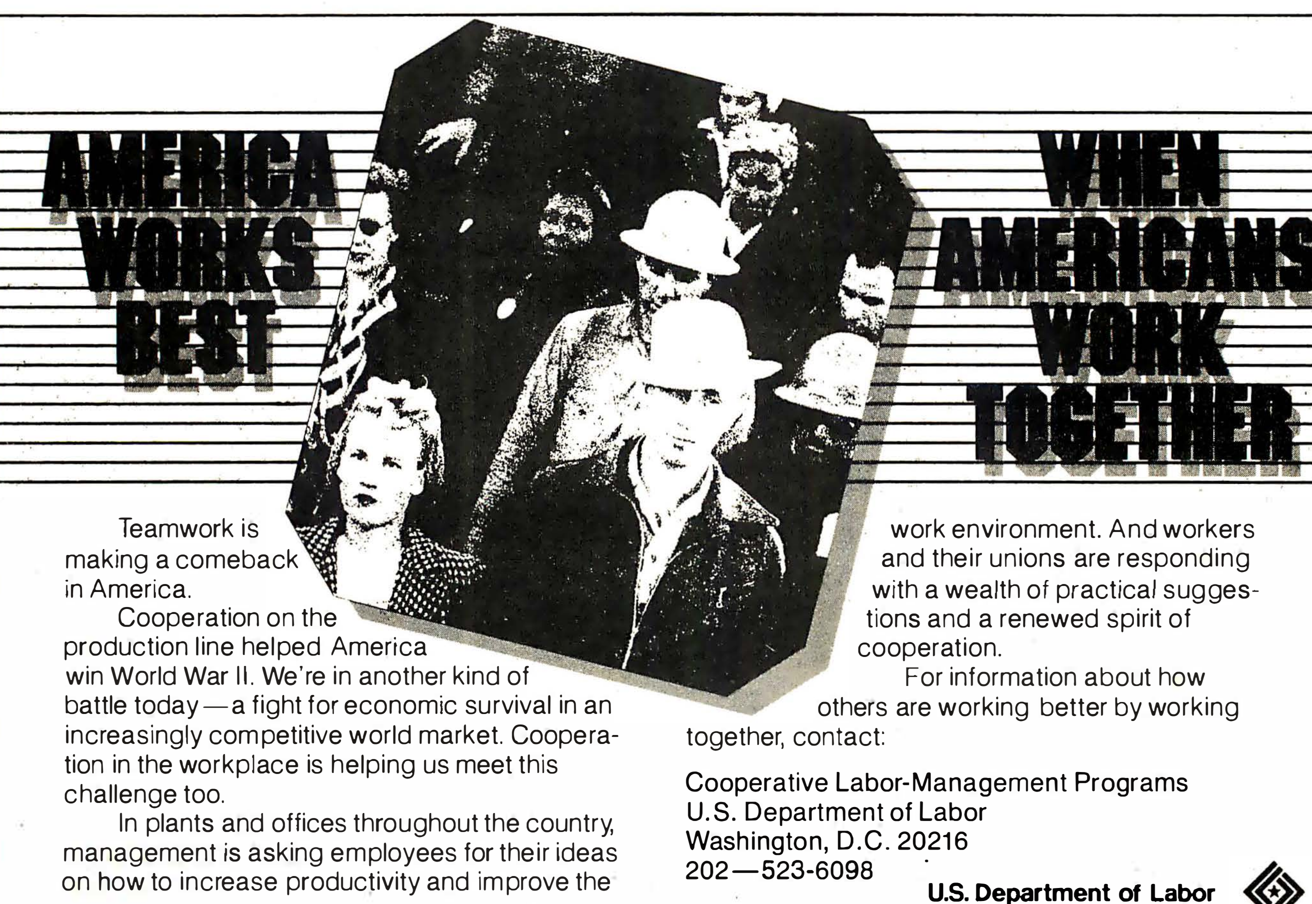
$39



The Remex drive is suitable for IBM/PC and all other applications requiring double sided Tandon 100-2 compatibility. The units are 2/3 the height of a standard disk drive and will allow three Remexes to fit in the space of two standard height drives. All drives are new factory packed units. RMX-480

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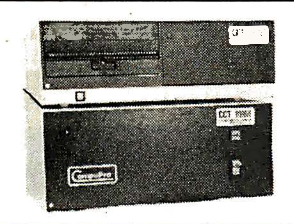
FOR TECHNICAL SUPPORT/ SERVICE / IN ARIZONA: 602-282-6299

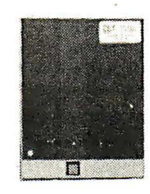
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80286 NOW!

☐ **CCT-286Z** is our model designation for the **MI-286** dual processor board from **Macrotech.** It features the super high speed combination of Z-80H and 80286, with provision for the 80287 math chip. Directly replaces 8085/88 and 8086 CPUs running CP/M, MP/M Concurrent DOS, and MS-DOS, at throughput increases of 3X to 5X!

SPECIAL PRICE - $1099
80287 Option - Installed - **$395**

SEE THE CCT-4 SERIES USING THIS BOARD DETAILED ON THE FACING PAGE

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dBASE II - Latest Version 2.4 .... $349
Supercalc 86 ... $99☐Supercalc 2 ... $259
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DRI Pascal Compiler 80 .. $279☐86 .. $449
DRI GSX-86 $79☐Assembler Tools/RMAC $179
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Supersoft FORTRAN IV. $339☐C Comp. $399

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200-14" GREEN-80/132 Super Deluxe . $569
220-14" GREEN-DEC Compatible $699
CCT RECOMMENDS—
AMBER Screen Options $20

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82 - 80 Col ... **$329** **83** - 132 Col ... **$619**
92 - 80 Col ... **$429** **93** - 132 Col ... **$659**
84 - 132 Col/200cps—Top of the Line . **$799**
For Serial Interfaces — Add $100

DIABLO — Letter Quality Series
Model 620 .. **$969** **Model 630** .. **$1799**

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S-100 HARD DISK SUBSYSTEMS

Professionally engineered ST-506 type systems for the business market S-100 Computer user. Includes industry top quality drives, CompuPro Disk 3 DMA controller, all cabling, A&T, formatted, burned-in. Provisions for up to two hard disks in each system. We include operating system update. CP/M 80, CP/M 86, CP/M 8-16, MP/M 8-16, CP/M 68K. (/1 Systems are CCT innovated hard/floppy combinations, with Mitsubishi DSDD 8" drive.) 12 month warranty.

CCT-10 (11 + MEG)	**$1799**	CCT-10/1	**$2349**
CCT-20 (22 + MEG)	**$2319**	CCT-20/1	**$2869**
CCT-40 (36 + MEG)	**$2799**	CCT-40/1	**$3349**
CCT-60 (58 + MEG) (New)	**$3999**	CCT-60/1	**$4549**
CCT-90 (87 + MEG) (New)	**$5209**	CCT-90/1	**$5759**
CCT-125 (123 + MEG) (New)	**$6399**	CCT-125/1	**$6949**

Drive capacities shown are **after** formatting! We are working on tape cartridge back-up units.

FLOPPY SYSTEMS

CCT-2.4 • Dual 8" DSDD
Mitusbishi 2.4 Megabyte in Extra Heavy horizontal enclosure, removeable filter air system, all cabling, A&T, Burned in. The fastest system available: $1229

CCT-5 • 5¼" DSDD
IBM Compatible Tandon 320K. Extra Heavy Cabinet accommodates two drives, hard or floppy. All cabling, A&T, Burned-in. Perfect for our MS-DOS Package $399

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CCT-2 - **$6799** • CCT-3 - **$6699** • Disk 1A w/CP/M - **$619** • CPU 8086/87 - **$819** • M-Drive/H - **$1099**
CPU 8085/88 - **$349** • CPU 8086 - **$559**/10Mhz - **$599** • **CPU 68K** - **$519**/10Mhz - **$639**
CPU-Z - **$249** • Disk 1A - **$519** • Disk 3 - **$499** • RAM 23/64K - **$309**/128K - **$599** • RAM 21 (128K) - **$749**
★ RAM 16 CLOSE-OUT SPECIAL - $249 ★
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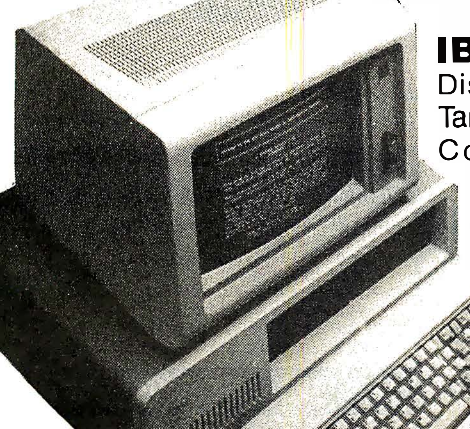
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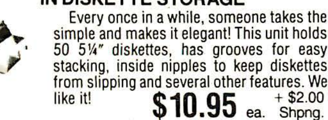
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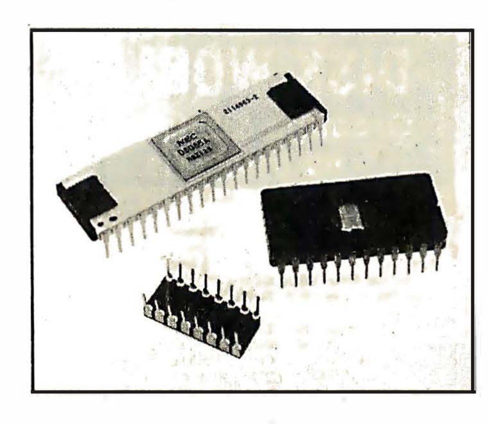
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74LS04	.40	74LS91	.75	74LS221	1.30
74LS08	.40	74LS93	.66	74LS240	1.60
74LS10	.40	74LS107	.46	74LS241	1.30
74LS11	.40	74LS109	.46	74LS242	1.30
74LS12	.36	74LS112	.50	74LS243	1.30
74LS14	.76	74LS122	.53	74LS244	1.49
74LS20	.38	74LS124	2.90	74LS245	1.49
74LS21	.38	74LS132	.91	74LS251	.75
74LS30	.38	74LS137	.99	74LS257	.75
74LS32	.50	74LS138	.87	74LS258	.75
74LS37	.40	74LS147	2.75	74LS266	.79
74LS38	.40	74LS151	.66	74LS273	1.69
74LS40	.38	74LS153	.69	74LS373	1.49
74LS42	.66	74LS157	.65	74LS374	1.49
74LS51	.36	74LS158	.65	74LS377	1.49
74LS54	.38	74LS161	.75	74LS640	3.49
74LS63	1.50	74LS166	1.95	74LS669	1.99
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74S08	.49	74S161	1.87
74S10	.45	74S169	3.99
74S11	.49	74S174	.99
74S20	.49	74S181	4.39
74S22	.45	74S194	1.99
74S30	.35	74S197	1.79
74S32	.59	74S240	2.20
74S37	.89	74S241	2.40
74S38	.99	74S244	2.20
74S74	.89	74S251	.95
74S86	.95	74S253	.95
74S112	1.19	74S257	.95
74S113	1.19	74S260	.79
74S124	2.99	74S273	2.45
74S132	1.59	74S287	2.29
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74S139	.97	74S374	3.39
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LM350	4.95	LM1458	.59
LM380	.89	LM2900	.85
LM393	1.29	LM3900	.79
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7404	.39	7489	3.40	74164	.99
7406	.89	7498	.47	74166	1.50
7407	.89	7492	.69	74174	.99
7408	.41	74107	.39	74181	2.39
7410	.35	74109	.59	74191	1.15
7411	.39	74123	.69	74193	.99
7420	.35	74125	.69	74194	.99
7421	.49	74132	.59	74221	1.35
7427	.45	74147	1.75	74273	1.95
7430	.35	74151	.79	74366	.99
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7438	.49	74154	1.25	74393	1.35
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4002	.35	74C02	.47
4008	.95	74C04	.47
4010	.57	74C08	.47
4011	.37	74C10	.47
4012	.37	74C20	.49
4020	.87	74C30	.49
4021	.95	74C73	.87
4022	.87	74C74	.79
4030	.57	74C86	.59
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4040	.97	74C93	1.75
4041	.97	74C151	2.25
4050	.47	74C157	1.75
4069	.35	74C161	1.79
4071	.35	74C173	.79
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4502	.95	74C193	1.49
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74LS02	.25	74LS169	1.35
74LS03	.25	74LS170	1.35
74LS04	.30	74LS173	1.35
74LS05	.25	74LS174	.85
74LS08	.30	74LS175	.90
74LS09	.30	74LS181	2.50
74LS10	.25	74LS190	1.45
74LS11	.30	74LS191	1.45
74LS12	.30	74LS192	1.45
74LS13	.75	74LS193	1.45
74LS14	.75	74LS194	1.45
74LS15	.35	74LS195	1.45
74LS20	.25	74LS196	1.35
74LS21	.30	74LS197	1.35
74LS22	.30	74LS221	1.35
74LS26	.30	74LS240	1.85
74LS27	.30	74LS242	1.85
74LS28	.30	74LS243	1.85
74LS40	.30	74LS244	2.25
74LS42	.35	74LS245	3.95
74LS48	.35	74LS247	1.65
74LS51	.35	74LS248	1.65
74LS54	.35	74LS249	1.65
74LS55	.35	74LS251	1.75
74LS73	.35	74LS253	1.75
74LS74	.45	74LS258	1.50
74LS75	.45	74LS259	2.95
74LS76	.45	74LS260	1.15
74LS78	.75	74LS261	3.75
74LS83A	.75	74LS266	1.35
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74LS90	.75	74LS279	.75
74LS92	.75	74LS283	.75
74LS93	.75	74LS290	.75
74LS95	.75	74LS293	1.25
74LS96	.75	74LS295	1.65
74LS107	.35	74LS298	1.65
74LS109	.45	74LS323	2.95
74LS113	.75	74LS324	1.15
74LS114	.75	74LS347	1.55
74LS122	.95	74LS348	1.45
74LS123	.95	74LS352	1.65
74LS124	.95	74LS353	1.95
74LS125	.75	74LS363	1.95
74LS126	.75	74LS365	1.25
74LS132	.95	74LS366	1.25
74LS133	.75	74LS367	.95
74LS136	.75	74LS368	.95
74LS138	.95	74LS373	1.95
74LS139	.95	74LS374	1.95
74LS145	.95	74LS375	.95
74LS148	.95	74LS377	.95
74LS151	.75	74LS378	1.55
74LS153	.75	74LS379	1.55
74LS154	.95	74LS381	1.95
74LS155	.75	74LS385	1.95
74LS156	.75	74LS386	1.25
74LS157	.75	74LS390	2.55
74LS158	.75	74LS393	1.55
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74S195	2.55
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4.0	2.95
5.0	2.95
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5.185	2.95
5.7143	2.95
6.0	2.95
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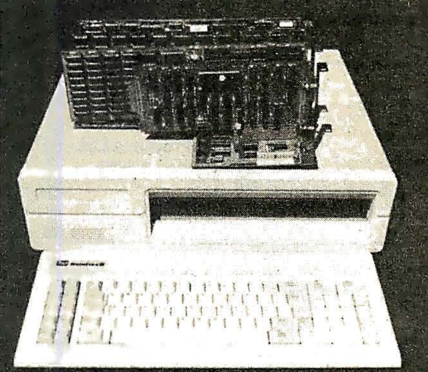
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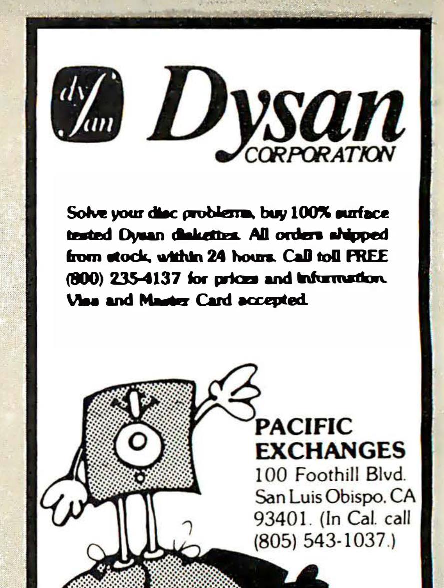


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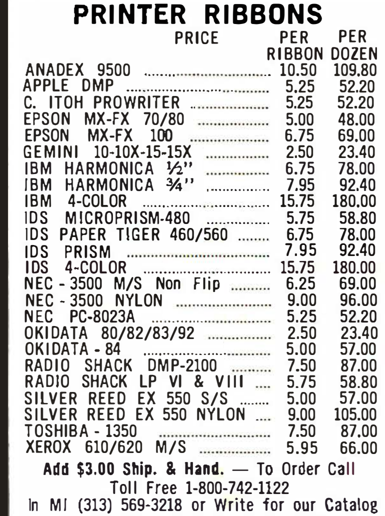
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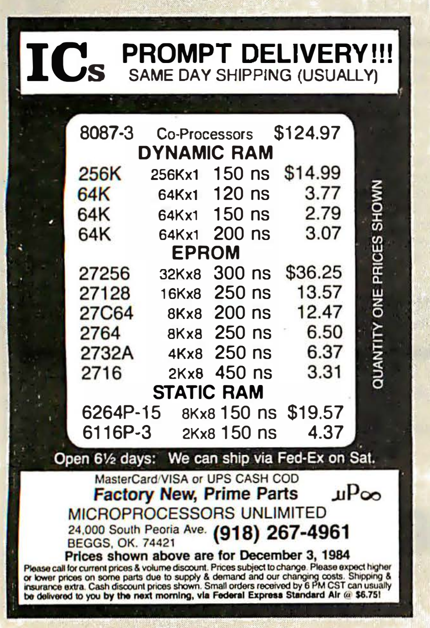
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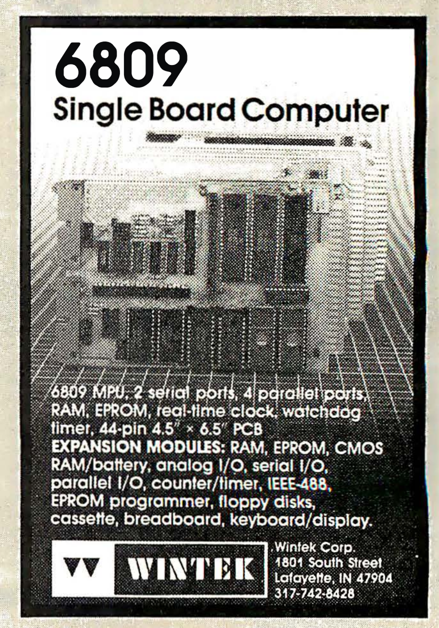
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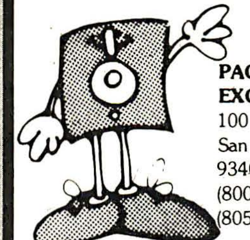
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LM311CN	.62	LM733	.98	CA3039	1.25
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LM318CN	1.45	LM741CN	.33	CA3059	2.65
LM318H	1.55	LM741H	.40	CA3060	2.85
LM319N	1.19	LM741N	.29	CA3065	1.69
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LM324N	.55	LM748	.55	CA3081	1.60
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7403	.19	7450	.19	74128	.49	74180	.75
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7406	.49	7454	.19	74141	.85	74184	2.25
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7408	.24	7460	.37	74143	3.70	74190	.67
7409	.19	7470	.29	74144	2.95	74191	.67
7410	.19	7472	.29	74145	.59	74192	.67
7411	.24	7473	.33	74147	1.49	74193	.67
7412	.36	7474	.34	74148	1.19	74194	.67
7413	.34	7475	.38	74150	1.09	74195	.67
7414	.49	7476	.34	74151	.55	74196	.75
7416	.49	7479	4.60	74152	.67	74197	.86
7417	.49	7480	.69	74153	.53	74198	1.15
7420	.19	7482	.95	74154	1.19	74199	1.15
7421	.35	7483	.45	74155	.69	74221	1.19
7422	.45	7485	.55	74156	.59	74251	.75
7423	.58	7486	.35	74157	.59	74273	1.65
7425	.29	7489	1.95	74158	1.65	74278	1.89
7426	.29	7490	.35	74159	1.58	74279	.75
7427	.25	7491	.65	74160	.79	74283	1.40
7428	.55	7492	.45	74161	.69	74284	2.90
7430	.16	7493	.35	74162	.69	74285	2.90
7432	.29	7494	.65	74163	.69	74290	1.49
7437	.25	7495	.50	74164	.69	74298	1.49
7438	.29	7496	.69	74165	.69	74365	.55
7439	.56	7497	2.70	74166	.85	74366	.55
7440	.19	74100	1.50	74167	2.75	74367	.55
7441	.79	74107	.24	74170	1.25	74366	.55
7442	.45	74109	.37	74172	4.75	74390	1.45
7443	1.15	74116	1.45	74173	.69	74393	1.33
7444	1.15	74121	.29	74174	.69	74490	2.25
7445	.68	74122	.44	74175	.69		

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74LS04	.33	74LS124	2.75	74LS253	.59
74LS05	.25	74LS125	.49	74LS257	.59
74LS08	.27	74LS126	.49	74LS258	.59
74LS09	.28	74LS132	.59	74LS259	2.95
74LS10	.25	74LS136	.39	74LS260	.59
74LS11	.33	74LS138	.59	74LS261	2.49
74LS12	.33	74LS139	.59	74LS266	.55
74LS13	.39	74LS145	1.19	74LS273	1.45
74LS14	.59	74LS146	1.36	74LS275	3.29
74LS15	.33	74LS151	.55	74LS279	.59
74LS20	.26	74LS153	.55	74LS283	.68
74LS21	.29	74LS154	1.49	74LS290	.88
74LS22	.29	74LS155	.69	74LS293	.78
74LS26	.29	74LS156	.69	74LS295	.98
74LS27	.29	74LS157	.69	74LS298	.88
74LS28	.29	74LS158	.69	74LS324	1.75
74LS30	.25	74LS160	.69	74LS347	1.95
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74LS33	.53	74LS162	.69	74LS352	1.25
74LS37	.35	74LS163	.69	74LS353	1.25
74LS38	.39	74LS164	.69	74LS363	1.29
74LS40	.25	74LS165	.90	74LS365	.48
74LS42	.44	74LS166	1.90	74LS366	.48
74LS47	.74	74LS168	1.15	74LS367	.45
74LS48	.74	74LS169	1.15	74LS368	.45
74LS51	.25	74LS170	1.40	74LS373	1.39
74LS54	.29	74LS173	.67	74LS374	1.39
74LS55	.29	74LS174	.67	74LS375	.69
74LS73	.39	74LS175	.67	74LS377	1.38
74LS74	.34	74LS181	1.95	74LS385	1.95
74LS75	.39	74LS190	.85	74LS386	.45
74LS76	.39	74LS191	.85	74LS390	1.15
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4007	.25	4032	2.15	4070	.35	4510	.79
4008	.95	4034	1.91	4071	.28	4511	.79
4009	.39	4035	.79	4072	.28	4512	.79
4010	.39	4037	1.95	4073	.28	4514	1.18
4011	.24	4040	.75	4075	.28	4515	1.79
4012	.24	4041	.75	4076	.75	4516	1.19
4013	.35	4042	.65	4077	.35	4518	.85
4014	.75	4043	.65	4078	.35	4520	.75
4015	.39	4044	.69	4081	.29	4555	.95
4016	.35	4046	.80	4082	.29	4558	.95
4017	.65	4047	.89	4085	.95	4566	1.35
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2732A	(350ns)	4.45
MC68766	8192 x 8 (450ns) (5v) (24 pin)	29.95
27128	16384 x 8 (250ns) (5v)	24.95

5v = Single 5 Volt Supply

74LS00

74LS00	.23	74LS125	.48	74LS260	.58
74LS01	.24	74LS128	.48	74LS268	.54
74LS02	.24	74LS132	.58	74LS273	1.45
74LS03	.24	74LS133	.58	74LS275	3.30
74LS04	.23	74LS136	.38	74LS279	.48
74LS05	.24	74LS137	.98	74LS290	1.95
74LS08	.27	74LS138	.54	74LS283	.88
74LS09	.28	74LS139	.54	74LS290	.88
74LS10	.24	74LS145	1.15	74LS293	.88
74LS11	.34	74LS147	2.45	74LS295	.98
74LS12	.34	74LS148	1.30	74LS298	.88
74LS13	.44	74LS151	.54	74LS299	1.70
74LS14	.58	74LS153	.54	74LS323	3.45
74LS15	.34	74LS154	1.85	74LS324	1.70
74LS20	.24	74LS165	.88	74LS352	1.25
74LS21	.28	74LS156	.88	74LS353	1.25
74LS22	.24	74LS157	.84	74LS383	1.30
74LS26	.28	74LS158	.58	74LS364	1.90
74LS27	.28	74LS160	.68	74LS365	.48
74LS28	.34	74LS161	.84	74LS366	.48
74LS30	.24	74LS162	.88	74LS367	.44
74LS32	.28	74LS163	.84	74LS368	.44
74LS33	.54	74LS164	.68	74LS373	1.36
74LS37	.34	74LS165	.94	74LS374	1.35
74LS38	.34	74LS166	1.90	74LS377	1.35
74LS40	.24	74LS168	1.70	74LS378	1.13
74LS42	.48	74LS169	1.70	74LS378	1.30
74LS47	.74	74LS170	1.45	74LS385	1.85
74LS48	.74	74LS173	.88	74LS388	.44
74LS49	.74	74LS174	.54	74LS390	1.15
74LS51	.24	74LS175	.54	74LS393	1.15
74LS54	.28	74LS181	2.10	74LS395	1.15
74LS55	.28	74LS189	8.90	74LS399	1.45
74LS63	1.20	74LS190	.88	74LS424	2.90
74LS73	.38	74LS191	.88	74LS447	.38
74LS74	.34	74LS192	.78	74LS490	1.90
74LS75	.38	74LS193	.78	74LS624	3.95
74LS76	.38	74LS194	.88	74LS640	2.15
74LS78	.48	74LS195	.88	74LS645	2.15
74LS83	.59	74LS196	.78	74LS668	1.85
74LS85	.88	74LS197	.78	74LS669	1.85
74LS86	.38	74LS221	.88	74LS670	1.45
74LS90	.64	74LS240	.94	74LS674	9.80
74LS91	.88	74LS241	.98	74LS682	3.15
74LS92	.64	74LS242	.98	74LS683	3.15
74LS93	.54	74LS243	.98	74LS684	3.15
74LS95	.74	74LS244	1.25	74LS685	3.15
74LS96	.88	74LS245	1.45	74LS688	2.35
74LS107	.38	74LS247	.74	74LS689	3.15
74LS109	.38	74LS248	.98	74LS783	23.95
74LS112	.38	74LS249	.68	81LS95	1.45
74LS113	.38	74LS251	.58	81LS96	1.45
74LS114	.38	74LS253	.58	81LS97	1.45
74LS122	.44	74LS257	.58	81LS98	1.45
74LS123	.78	74LS258	.68	25LS2521	2.75
74LS124	2.85	74LS259	2.70	25LS2589	4.20

CRT CONTROLLERS

6845	11.95
7220	38.95
CRT 5027	18.95
CRT 5037	28.95
TMS 9918A	36.95
HO 46505sp	11.95

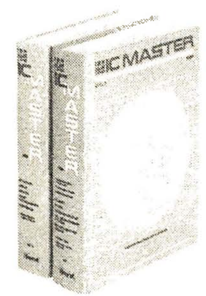
DISC CONTROLLERS

1771	14.95	2797	54.95
1791	21.95	6843	33.95
1793	25.95	8272	18.95
1795	21.95	UP0765	18.95
1797	21.95	M68876	23.95
2791	49.95	M68877	25.95
2793	49.95	1691	6.95
2795	54.95	2143	6.95

1984

— THE IC MASTER —

Your ticket to fast and easy IC selections



$ 89.95

6500

1 MHZ		2 MHZ	
6502	4.90	6502A	6.90
6504	6.90	6522A	9.90
6505	8.90	6632A	10.95
6507	9.90	6545A	26.95
6520	4.30	6551A	10.95
6522	6.90	**3 MHZ**	
6532	9.90	65028	8.95
6545	21.50		
6551	10.85		

6800

68000	45.95	6860	6.95
6800	2.75	6862	10.95
6802	7.90	6875	6.90
6808	12.90	6880	2.20
6809E	13.95	6883	21.95
6809	10.95	68047	23.96
6810	2.90	68488	18.95
6820	4.30		
6621	2.75	**1 MHZ**	
6828	13.95	68800	9.95
6840	11.95	68802	21.25
6843	33.95	68809E	28.95
6844	24.95	68809	28.95
6845	11.95	68810	6.90
6847	10.95	68821	6.90
6850	3.20	68845	18.95
6852	4.95	68850	5.90

MICROPROCESSORS

8000

8031	5.75	8088	25.95
8035	5.90	8089	59.95
8039	5.75	8155	6.90
INS-8060	16.95	8155-2	7.90
INS-8073	45.95	8156	6.90
8080	3.90	8185	28.95
8085	4.75	8185-2	38.95
8085A-2	10.95	8741	19.95
8086	23.95	8748	35.95
8087	159.95	8755	23.95

8200

8202	23.95	8255-5	5.20
8203	38.95	8257	7.90
8205	3.45	8257-5	8.90
8212	1.75	8259	6.85
8214	3.80	8259-5	7.45
8216	1.70	8271	75.00
8224	2.20	8272	38.95
8226	1.75	8274	29.95
8228	3.45	8275	28.95
8237	18.95	8279	8.90
8237-5	20.95	8279-5	9.00
8238	4.45	8282	6.45
8243	3.95	8283	6.45
8250	9.95	8284	4.95
8251	4.45	8286	6.45
8253	6.90	8287	6.45
8253-5	7.90	8288	24.00
8255	4.45	8289	13.95
		8292	16.95

Z-80

2.5 MHZ		4.0 MHZ	
Z80-CPU	2.95	Z80A-CPU	3.95
Z80-CTC	2.95	Z80A-CTC	3.95
Z80-DART	8.95	Z80A-DART	8.95
Z80-DMA	11.95	Z80A-DMA	8.95
Z80-PIO	2.95	Z80A-PIO	3.95
Z80-SIO/0	10.95	Z80A-SIO/0	11.95
Z80-SIO/1	10.95	Z80A-SIO/1	11.95
Z80-SIO/2	10.95	Z80A-SIO/2	11.95
Z80-SIO/9	10.95	Z80A-SIO/9	11.95

6.0 MHZ		ZILOG	
Z80B-CPU	8.95	Z6132	33.95
Z80B-CTC	8.95	Z8671	38.95
Z80B-PIO	8.95		
Z80B-DART	12.95		

MEMORY EXPANSION KIT



4164 200ns
9 for $29.97

Low Cost EPROM – PROGRAMMER –

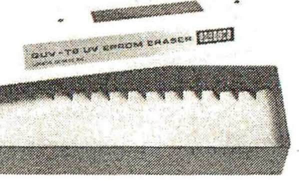


The "Shooter" $395.00

- 32K bits upgradable to 128K memory
- Built-In Serial RS-232 Port
- Program & verify 2716 thru 27256
- Intelligent, fast programming
- Up/download Hex, Binary, ASCII etc.
- Serial RS-232 interface compatible

UV ERASERS

QUV-T8/1 $49.95
ECONOMY Model



- Erases 8 EPROMS in 20 minutes
- Plastic Enclosure

QUV-T8/2T $97.50
INDUSTRIAL Model

- Tray Action,
- UV Indicator
- 60-minute adjustable timer
- Steel enclosure
- Safety switch
- Erase 15 EPROMS in 20 minutes

QUV-T8/2N $68.95
(No Timer)

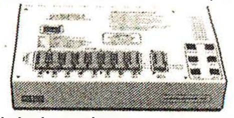
LUV-1 $149.95
PRODUCTION Model

QUV-T8/2 $124.95
FAST Industrial Model

ST-8 $195.00
8-Tray Storage Cabinet

GANG PROGRAMMER

GANGPRO-8™ $995.00



- High through-put
- Reliable, user-friendly
- Intelligent algorithm
- Program and verify 2716 thru 27256
- Stand alone (RS-232 option $185)

OTHER PRODUCTS:

PROMPRO-8 $689.00
64K Version

- Powerful EPROM/Micro development programmer
- Keypad simulation
- 256K memory buffer option available

PROMPRO-7 $489.00

- 32K non-expandable unit
- Built-in 8748, 8749 programming

PALPRO-2 $1895.00
Stand-alone RS-232 Unit

- Programs 20 and 24 series PALs

PALPRO-1 $995.00
Programs 20-pin PALs

LOGICAL DEVICES, INC.

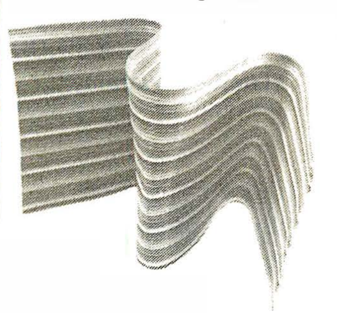


DIP SWITCHES



4 POSITION	.79
5 POSITION	.85
6 POSITION	.85
7 POSITION	.69
8 POSITION	.89

RIBBON CABLE



CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10"
10	.45	4.30	.78	7.20
16	.50	4.70	.95	8.70
20	.60	5.60	1.15	10.90
25	.70	6.50	1.22	11.50
26	.70	6.50	1.27	11.50
34	.93	8.50	1.55	14.40
40	1.27	11.50	1.82	16.70
50	1.28	12.00	2.40	21.90

IC SOCKETS
(1 to 99)

8 pin ST.	.12	8 pin WW.	.58
14 pin ST.	.14	14 pin WW.	.68
16 pin ST.	.16	16 pin WW.	.68
18 pin ST.	.19	18 pin WW.	.98
20 pin ST.	.28	20 pin WW.	1.04
22 pin ST.	.29	22 pin WW.	1.34
24 pin ST.	.29	24 pin Ww.	1.44
28 pin ST.	.39	28 pin WW.	1.64
40 pin ST.	.48	40 pin WW.	1.94

ST = Soldertall WW = Wirewrap

ZIF SOCKETS



14 pin ZIF	5.45
16 pin ZIF	5.45
24 pin ZIF	7.45
28 pin ZIF	8.45
40 pin ZIF	10.45

ZIF = TEXTOOL (Zero Insertion Force)

VOLTAGE REGULATORS

7805T	.74	7905T	.84
78M05C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
78L05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	9.90		

C,T = TO-220 K = TO-3
L = TO-92

CRYSTALS

1.0000 MHz	3.89	8.0000 MHz	2.69
1.8432 MHz	3.69	10.0000 MHz	2.69
2.0000 MHz	2.89	10.7388 MHz	2.89
2.0972 MHz	2.69	12.0000 MHz	2.69
2.4576 MHz	2.69	14.3182 MHz	2.69
3.2768 MHz	2.69	15.0000 MHz	2.69
3.5795 MHz	2.69	18.0000 MHz	2.89
4.0000 MHz	2.69	17.4300 MHz	2.89
4.1943 MHz	2.69	18.0000 MHz	2.69
4.9160 MHz	2.69	18.4320 MHz	2.69
5.0000 MHz	2.69	19.6608 MHz	2.69
5.0688 MHz	2.69	20.0000 MHz	2.69
5.1850 MHz	2.69	22.1184 MHz	2.69
5.2429 MHz	2.69	32.0000 MHz	2.69
5.7143 MHz	2.69	36.0000 MHz	2.69
6.0000 MHz	2.69	48.0000 MHz	2.69
6.1440 MHz	2.69	49.4350 MHz	2.69
6.4000 MHz	2.69	49.8900 MHz	2.69
6.5538 MHz	2.89		

32.768 KHz...... 1.69

CRYSTAL CLOCK OSCILLATORS

PART NO.	FREQUENCY	PRICE
1.000	1.0000 MHz	6.99
1.643	1.8432 MHz	6.99
2.000	2.0000 MHz	6.99
4.000	4.0000 MHz	6.99
6.000	8.0000 MHz	6.99
10.000	10.0000 MHz	6.99
16.000	16.0000 MHz	6.99
16.432	18.4320 MHz	5.99
19.660	19.6608 MHz	6.99
20.000	20.0000 MHz	6.99
32.000	32.0000 MHz	6.99

EDGECARD CONECTORS

S-100 ST	3.85	50-pin ST	4.85
S-100 WW	4.85	44-pin ST	2.85
72-pin ST	6.85		
72-pinWW	7.85	44-pinWW	4.85

RESISTORS

¼ WATT 5% CARBON FILM
ALL STANDARD VALUES
FROM 1 OHM - 10 MEG OHM

50 PCS	1.25
100 PCS	2.00
1,000 PCS	15.00

LED LAMPS



	1-99	100+
Jumbo RED	.09	.08
Jumbo GREEN	.16	.14
Jumbo YELLOW	.16	.14

INTERFACE CHIPS

8T26	1.54	8T98	.88
68T28	1.84	OM8131	2.90
8T95	.88	DP8304	2.24
8T96	.88	DS8835	1.94
8T97	.88	DS8836	.98

— TRANSISTORS —

2N918	.49	2N3563	.39	2N4402	.24
MPS918	.24	2N3585	.39	2N4403	.24
2N2102	.74	PN3565	.24	2N4857	.99
2N2218	.49	MPS3638	.24	PN4916	.24
2N2218A	.49	MPS3640	.24	2N5086	.24
2N2219	.49	PN3643	.24	PN5129	.24
2N2219A	.49	PN3644	.24	PN5139	.24
2N2222	.24	MPS3704	.14	2N5209	.24
PN2222	.09	MPS3706	.14	2N6028	.34
MPS2369	.24	2N3772	1.80	2N6043	1.70
2N2484	.24	2N3903	.24	2N6045	1.70
2N2905	.49	2N3904	.09	MPS-A05	.24
2N2907	.24	2N3908	.09	MPS-A06	.24
PN2907	1.20	2N4122	.24	MPS-A55	.24
2N3055	.78	2N4123	.24	TIP29	.64
3055T	.68	2N4249	.24	TIP31	.74
2N3393	.29	2N4304	.74	TIP32	.78
2N3414	.24	2N4401	.24		

DIP CONNECTORS

DESCRIPTION	ORDER BY	8	14	16	16	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	HRTxxST	.94	.94	.94	1.59	1.79	1.79	1.89	2.39	2.89
COMPONENT CARRIERS (DIP HEADERS)	ICCxx	.60	.70	.80	.95	1.15	1.15	1.25	1.40	2.00
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	—	1.35	1.55	—	—	—	2.40	—	4.05

(Column heading for the contact counts: NO. of CONTACTS)

ORDER EXAMPLE: A 14-pin High Rel. ST socket would be **HRT 14 ST**

D-SUBMINIATURE

DESCRIPTION		ORDER BY	9	15	25	37	50
SOLDER	MALE	DPxxP	1.98	2.59	2.40	4.70	5.96
CUP	FEMALE	DBxxS	2.56	3.53	3.15	7.01	9.14
RT. ANGLE	MALE	DBxxPR	1.55	2.10	2.90	4.73	—
PC. SOLDER	FEMALE	DBxxSR	2.08	2.93	4.32	6.09	—
IDC	MALE	IDPxxP	3.27	4.60	6.13	9.12	—
RIBBON CABLE	FEMALE	IDBxxS	3.59	5.03	6.74	9.98	—
HOODS	BLACK	HOOD-B	—	—	1.15	—	—
	GREY	HOOD	1.50	1.50	1.15	2.85	3.40

(Column heading for the contact counts: NO. of CONTACTS)

ORDER EXAMPLE: A **5-pin Male Solder Cup** would be **MALE DP 25 P**

IDC CONNECTORS

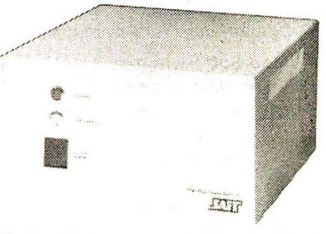
DESCRIPTION	ORDER BY	10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.77	1.19	1.58	2.10	2.48	3.14
RT. ANGLE SOLDER HEADER	IDHxxSR	.80	1.25	1.66	2.21	2.62	3.29
WW HEADER	IDHxxW	1.76	2.88	3.74	4.40	5.18	6.53
RT. ANGLE WW HEADER	IDHxxWR	1.95	3.18	4.12	4.35	4.70	7.20
RIBBON HEADER SOCKET	IDSxx	1.05	1.76	2.33	3.05	3.63	4.55
RIBBON HEADER	IDMxx	—	5.40	6.15	6.90	7.40	8.40
RIBBON EDGE CARD	IDExx	2.15	2.26	2.55	3.15	3.70	4.64

(Column heading for the contact counts: NO. of CONTACTS)

ORDER EXAMPLE: A 20-pin WW Header would be **IDH 20 W.**

SAFT Power Products:

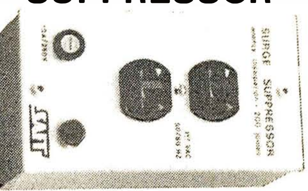
STANDBY POWER — SUPPLIES —



Protect your computer and its precious data from black-outs or brownouts. Turns on if the power goes off at the wall outlet!

SPS0200VA/117V	**$499.00**
SPS0400VA/117V	**$699.00**

SURGE - SUPPRESSOR -



STOPS lightening bolts or other high energy line surges from damaging your computer's sensitive components.

SURGE SUPPRESSOR **$149.00**

-EMI/RFI FILTER-



Eliminates line noise caused by office equipment, printers, flourescent lights, switches, etc.

INTERFERENCE FILTER **$49.95**

LINE -CONDITIONER-

Isolation transformer is harmonic compensating to hold line voltage steady, regulated; also suppresses pulses and line noise.

LINE CONDITIONER **$395.00**

ORDER TOLL FREE

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(CALIFORNIA RESIDENTS)

(800) 848-8008







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80-Column card for Apple II series

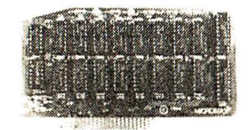
- Video Soft Switch
- Inverse Video
- VIDEX's Videoterm compatible



VIEWMAX-80e 119.95

80-Column extended video card for Apple IIe

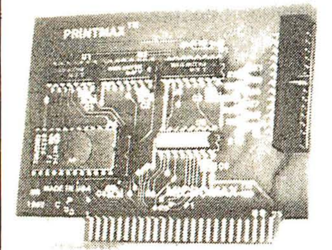
- 64K RAM, expandable to 128K
- Double High-resolution circuit
- Compatible with Pascal & CP/M



PRINTMAX 59.95

Parallel printer card, Apple II series

- Centronics compatible
- Variable print widths
- Up to 5000 characters/second



Z-MAX-80 89.00

Z-80 card for CP/M on Apple II series

- Softcard and Z-Card compatible
- Full interrupt and DMA operation

GRAPHMAX 99.95

Dual High-Res graphics printer card for Apple II series

- Grappler+ compatible
- Color and Zoom magnification
- Inverse graphics
- 90-degrees Rotation
- Pascal and CP/M compatible

MULTIVIEW 80/160 249.00

80-160 columns with any monitor!

- Screens: 80x24, 80x32, 80x48, 96x24, 132x24, 132x30, 160x24
- On-screen BOLD and Underline
- Reverse scrolling
- Easy-to-read *Wide-angle* mode
- Apple II and IIe compatible
- Prompt lines
- Upper & lowercase letters

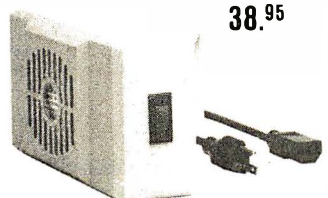


APPLE & IBM ACCESSORIES

80 Column Apple II+	149.95
80 Column Apple IIE	119.95
Z80 Apple II+	89.00
Z80 Apple IIE	89.00
16K Card	39.95
Cooling Fan	38.95
Power Supply	74.95
Joystick	29.95
RF Modulator	13.95
Disk Drive	169.95
Controller Card	59.95
Paddles	7.95

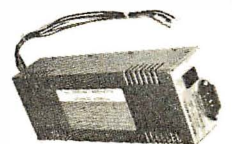
COOLING FAN

38.95



APPLE COMPATIBLE POWER SUPPLY

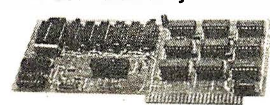




- Powers Apple type systems
- +5V @ 5A +12V @ 3A
  −5V @ .5A −12V @ .5A
- Includes Instructions

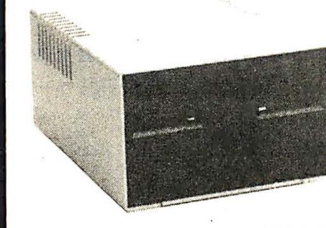
16K RAM Card – Apple II+

- 2-Year Warranty



Assembled & Tested 39.95

APPLE COMPATIBLE DISK DRIVE



169.95

- Shugart mechanism, made in U.S.A.
- Directly replaces Apple Disk II
- Fully compatible with Apple Controller or other Apple compatible controllers.
- One Year Warranty

FULL or ½-Height

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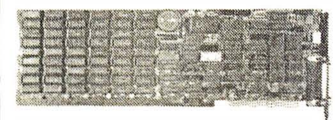
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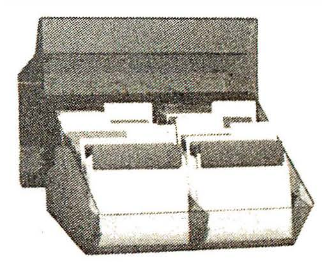
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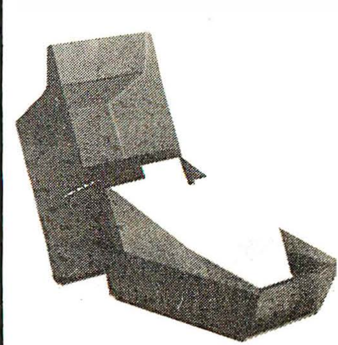
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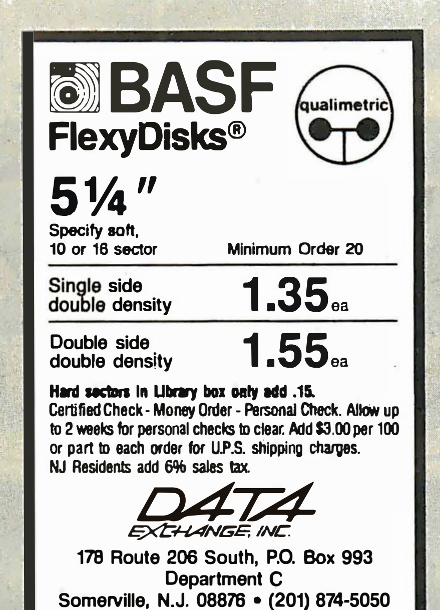
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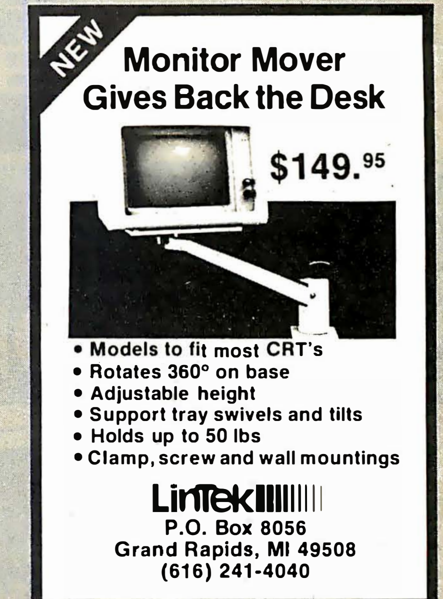
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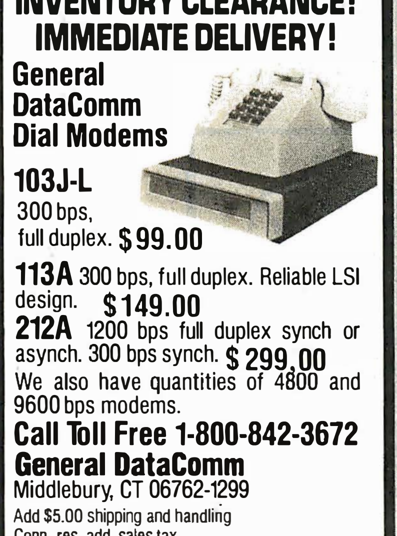
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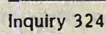
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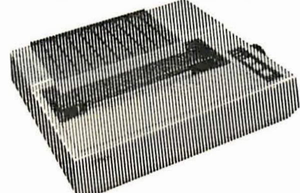
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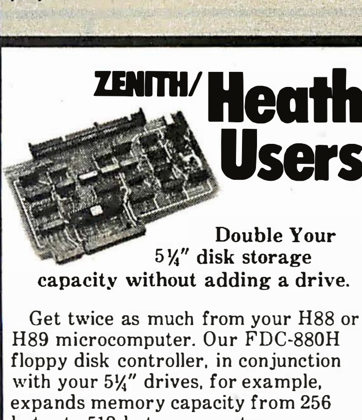


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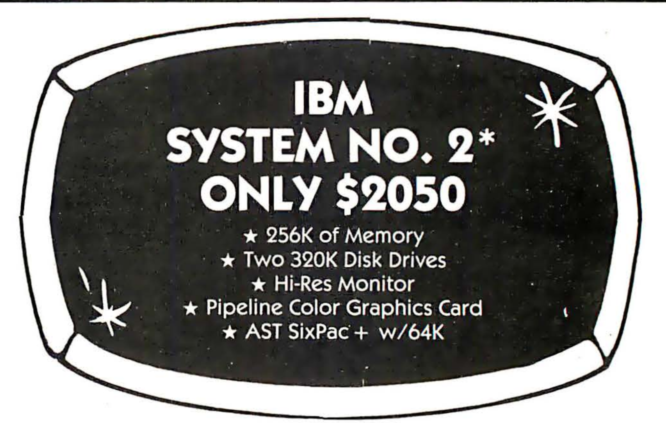
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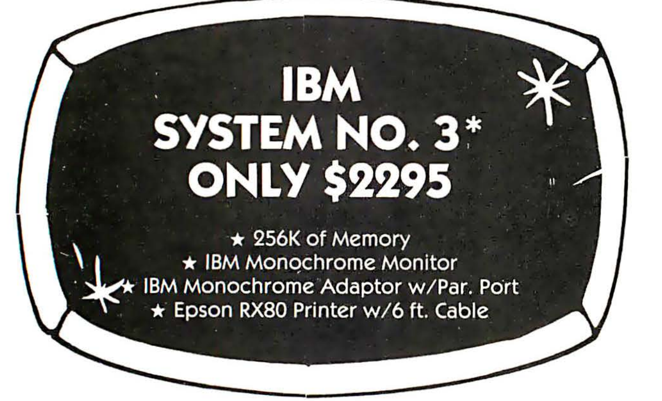
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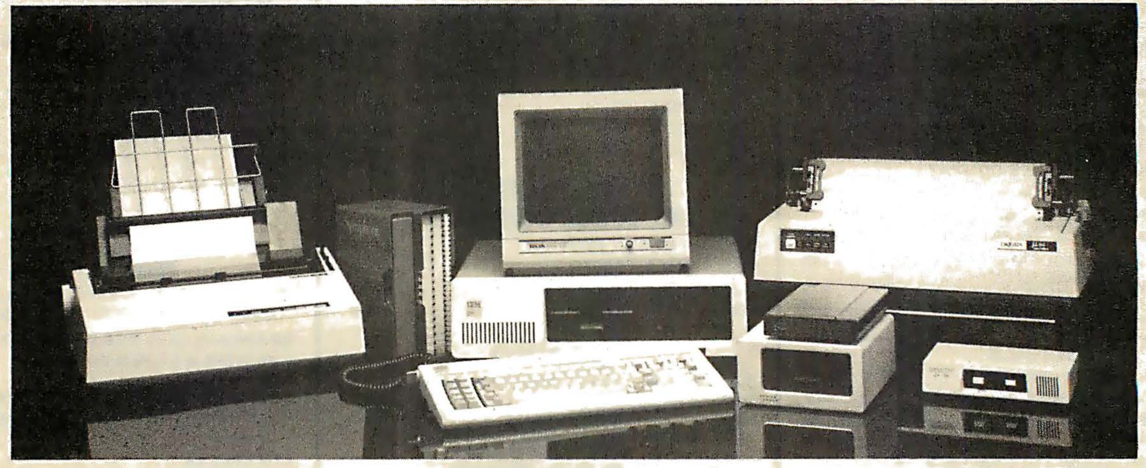
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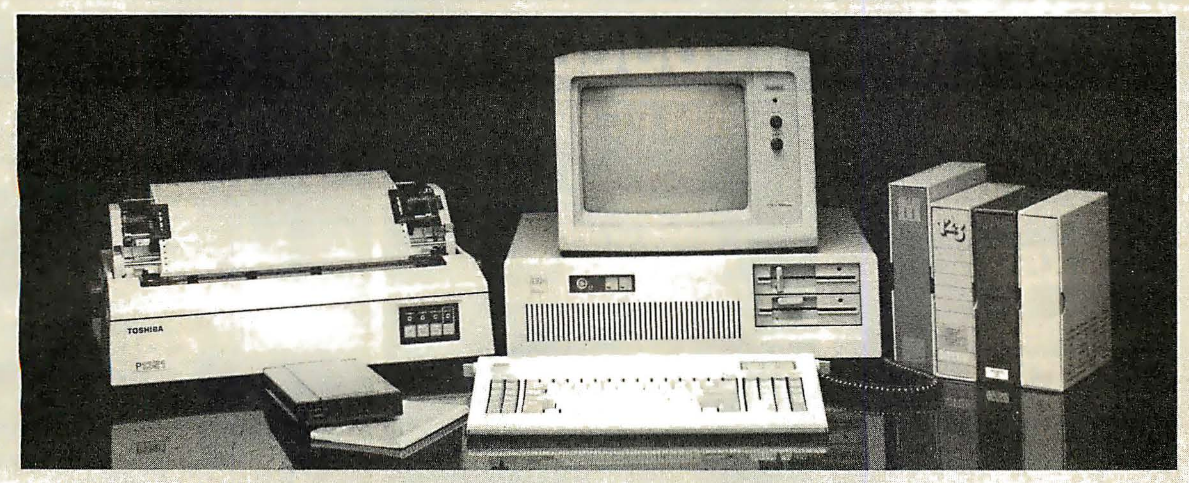
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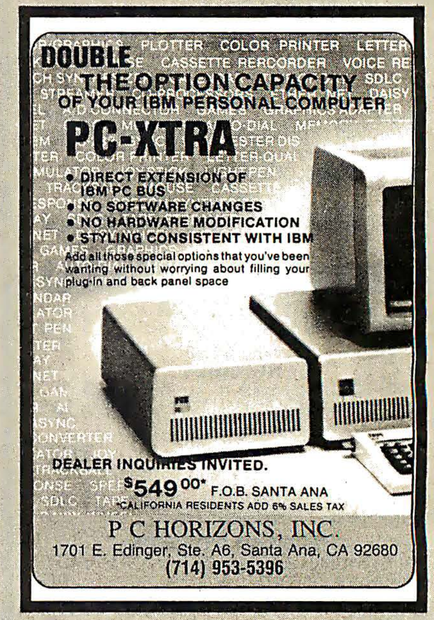
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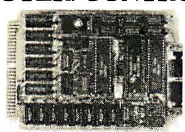
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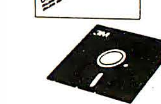
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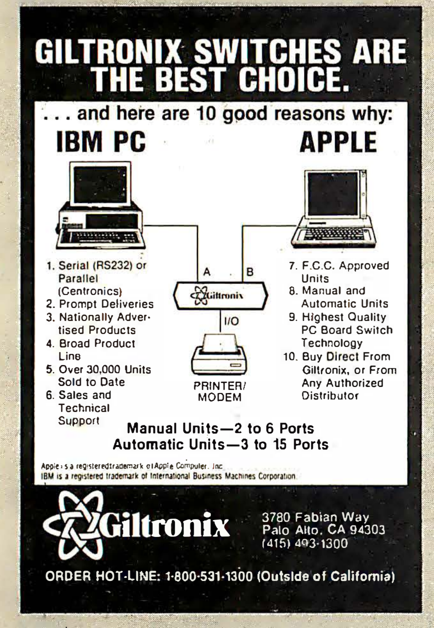
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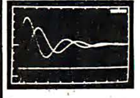
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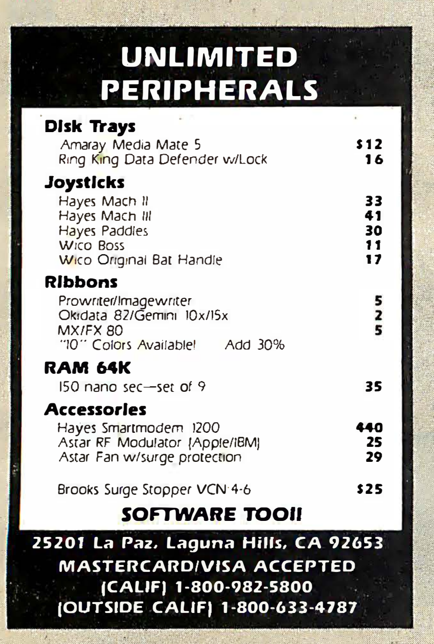
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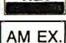
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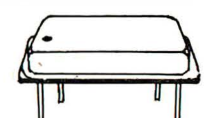
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7423	.29	74121	.29	74196	.79
7425	.29	74122	.45	74197	.75
7426	.29	74123	.49	74198	1.35
7427	.29	74125	.45	74199	1.35
7428	.45	74126	.45	74221	1.35
7430	.19	74128	.55	74246	1.35
7432	.29	74132	.45	74247	1.25
7433	.45	74136	.50	74248	1.85
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7438	.29	74142	2.95	74251	.75
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74HC157	.89	74HC4049	.89
74HC161	1.15	74HC4050	.89
74HC164	1.25	74HC4060	1.29
74HC166	2.95	74HC4511	2.39
74HC174	.99	74HC4538	2.29

74HCT00

74HCT: Direct, drop-in replacements for LS TTL and can be intermixed with 74LS in the same circuit.

74HCT00	.69	74HCT175	1.09
74HCT02	.69	74HCT193	1.39
74HCT04	.69	74HCT194	1.19
74HCT08	.69	74HCT195	1.29
74HCT10	.69	74HCT238	1.49
74HCT11	.69	74HCT240	2.19
74HCT14	.89	74HCT241	2.19
74HCT20	.69	74HCT242	2.19
74HCT27	.69	74HCT243	2.19
74HCT30	.69	74HCT244	2.19
74HCT32	.79	74HCT245	2.19
74HCT51	.69	74HCT251	1.09
74HCT74	.85	74HCT257	.99
74HCT75	.95	74HCT259	1.59
74HCT85	1.49	74HCT273	2.09
74HCT86	.79	74HCT299	5.25
74HCT93	1.29	74HCT367	1.09
74HCT125	1.29	74HCT373	2.49
74HCT132	1.29	74HCT374	2.49
74HCT138	1.15	74HCT393	1.59
74HCT139	1.15	74HCT4017	2.19
74HCT151	1.05	74HCT4020	1.59
74HCT153	1.05	74HCT4024	1.79
74HCT154	2.99	74HCT4040	1.59
74HCT157	.99	74HCT4049	.99
74HCT161	1.29	74HCT4050	.99
74HCT164	1.39	74HCT4060	1.49
74HCT166	3.05	74HCT4511	2.69
74HCT174	1.09	74HCT4538	2.59

SPECTRONICS CORPORATION

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	$83.00
PE-14T	x	9	8,000	$119.00
PE-24T	x	12	9,600	$175.00
PL-265T	x	30	9,600	$255.00
PR-125T	x	25	17,000	$349.00
PR-320T	x	42	17,000	$595.00

VOLTAGE REGULATORS

TO-220 CASE PACKAGE

7805T	.75	7905T	.85
7808T	.75	7908T	.85
7812T	.75	7912T	.85
7815T	.75	7915T	.85
7824T	.75	7924T	.85

TO-3 CASE PACKAGE

7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	7915K	1.49
7824K	1.39	7924K	1.49

TO-92 CASE PACKAGE

78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79

OTHER VOLTAGE REGS

78M05C	5volt	½amp	TO-220	.35
LM323K	5volt	3amp	TO-3	4.95
LM338K	Adj.	5amp	TO-3	3.95
78H05K	5volt	5amp	TO-3	9.95
78H12K	12volt	5amp	TO-3	9.95
78P05K	5volt	10amp	TO-3	14.95
UA78S40	FAIRCHILD		DIP	1.95

LINEAR

LM301	.34	LM567	.89
LM301H	.79	NE570	3.95
LM307	.45	NE571	2.95
LM308	.69	NE590	2.50
LM308H	1.15	NE592	.98
LM309H	1.95	LM709	.59
LM309K	1.25	LM710	.75
LM310	1.75	LM711	.79
LM311	.64	LM723	.49
LM311H	.89	LM723H	.55
LM312H	1.75	LM733	.98
LM317K	3.95	LM741	.35
LM317T	1.19	LM741N-14	.35
LM318	1.49	LM741H	.40
LM318H	1.59	LM747	.69
LM319H	1.90	LM748	.59
LM319	1.25	LM1014	1.19
LM320	see7900	LM1303	1.95
LM322	1.65	LM1310	1.49
LM323K	4.95	MC1330	1.69
LM324	.59	MC1349	1.89
LM329	.65	MC1350	1.19
LM331	3.95	MC1358	1.69
LM334	1.19	MC1372	6.95
LM335	1.40	LM1414	1.59
LM336	1.75	LM1458	.59
LM337T	1.95	LM1488	.69
LM337K	3.95	LM1489	.69
LM338K	3.95	LM1496	.85
LM339	.99	LM1558H	3.10
LM340	see7800	LM1800	2.37
LM348	.99	LM1812	8.25
LM350K	4.95	LM1830	3.50
LM350T	4.60	LM1871	5.49
LM358	.69	LM1872	5.49
LM359	1.79	LM1877	3.52
LM376	3.75	LM1889	1.95
LM377	1.95	LM1896	1.75
LM378	2.50	ULN2003	1.29
LM379	4.50	XR2206	3.75
LM380	.89	LM2877	2.05
LM380N-8	1.10	LM2878	2.25
LM381	1.60	LM2900	.85
LM382	1.60	LM2901	1.00
LM383	1.95	MPQ2907	1.95
LM384	1.95	LM2917	2.95
LM386	.89	LM3900	.59
LM387	1.40	LM3905	1.25
LM389	1.35	LM3909	.98
LM390	1.95	LM3911	2.25
LM392	.69	LM3914	3.95
LM393	1.29	LM3915	3.95
LM394H	4.60	LM3916	3.95
LM399H	5.00	MC4024	3.95
NE531	2.95	MC4044	4.50
NE555	.34	RC4136	1.25
NE556	.65	RC4151	3.95
NE558	1.50	LM4250	1.75
NE564	2.95	LM4500	3.25
LM565	.99	RC4558	.69
LM566	1.49	LM13600	1.49
		LM13700	1.45

H=TO-5 CAN, K=TO-3, T=TO-220

RCA

CA3023	2.75	CA3083	1.55
CA3039	1.29	CA3086	.80
CA3046	1.25	CA3089	2.99
CA3059	2.90	CA3096	3.49
CA3060	2.90	CA3130	1.30
CA3065	1.75	CA3140	1.15
CA3080	1.10	CA3146	1.85
CA3081	1.65	CA3160	1.19
CA3082	1.65	CA3183	.99

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75108	1.49	75453	.39
75110	1.95	75454	.39
75150	1.95	75491	.79
75154	1.95	75492	.79
75188	1.25	75493	.89
75189	1.25	75494	.89

BI FET

TL066	.99	LF347	2.19
TL071	.79	LF351	.60
TL072	1.19	LF353	1.00
TL074	2.19	LF355	1.10
TL081	.79	LF356	1.10
TL082	1.19	LF357	1.40
TL083	1.19	LF411	1.29
TL084	2.19	LF412	1.99

TRANSISTORS

2N918	.50	2N3772	1.85
MPS918	.25	2N3903	.25
2N2102	.75	2N3904	.10
2N2218	.50	2N3906	.10
2N2218A	.50	2N4122	.25
2N2219	.50	2N4123	.25
2N2219A	.50	2N4249	.25
2N2222	.25	2N4304	.75
PN2222	.10	2N4401	.25
MPS2369	.25	2N4402	.25
2N2484	.25	2N4403	.25
2N2905	.50	2N4857	1.00
2N2907	.25	PN4916	.25
PN2907	.13	2N5086	.25
2N3055	.79	PN5129	.25
3055T	.69	PN5139	.25
2N3393	.30	2N5209	.25
2N3414	.25	2N6028	.35
2N3563	.40	2N6043	1.75
2N3565	.40	2N6045	1.75
PN3565	.25	MPS-A05	.25
MPS3638	.25	MPS-A06	.25
MPS3640	.25	MPS-A13	.40
PN3643	.25	MPS-A55	.25
PN3644	.25	MPU-131	.99
MPS3704	.15	TIP29	.65
MPS3706	.15	TIP31	.75
		TIP32	.79

IC SOCKETS

	1-99	100
8 PIN ST	.13	.11
14 PIN ST	.15	.12
16 PIN ST	.17	.13
18 PIN ST	.20	.18
20 PIN ST	.29	.27
22 PIN ST	.30	.27
24 PIN ST	.30	.27
28 PIN ST	.40	.32
40 PIN ST	.49	.39
64 PIN ST	4.25	CALL

ST=SOLDERTAIL

8 PIN WW	.59	.49
14 PIN WW	.69	.52
16 PIN WW	.69	.58
18 PIN WW	.99	.90
20 PIN WW	1.09	.98
22 PIN WW	1.39	1.28
24 PIN WW	1.49	1.35
28 PIN WW	1.69	1.49
40 PIN WW	1.99	1.80

WW=WIREWRAP

INTERFACE

8T26	1.59
8T28	1.98
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8833	2.25
DS8835	1.99
DS8836	.99
DS8837	1.65
DS8838	1.30

INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

DATA AQC

ADC0800	15.55
ADC0804	3.49
ADC0809	4.49
ADC0816	14.95
ADC0817	9.95
ADC0831	8.95
DAC0800	4.49
DAC0806	1.95
DAC0808	2.95
DAC1020	8.25
DAC1021	7.95
DAC1022	5.95
MC1408L6	1.95
MC1408L8	2.95

EXAR

XR2206	3.75
XR2207	3.75
XR2208	3.75
XR2211	5.25
XR2240	3.25

9000

9304	.95
9316	1.00
9328	1.49
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
9637	2.95
96S02	1.95

SOUND CHIPS

76477	3.95
76488	5.95
76489	8.95
SSI-263	39.95
AY3-8910	12.95
AY3-8912	12.95
MC3340	1.49
SP1000	39.00

OPTO-ISOLATORS

4N26	1.00	MCA-7	4.25
4N27	1.10	MCA-225	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

MICRODEVICES AT MICROPRICES

VISA



DB25S RS232 FEMALE SOLDER CUP 2.25   DB25P RS232 MALE SOLDER CUP 1.90

BARGAIN HUNTERS CORNER

2 LEVEL WIRE WRAP SOCKETS

THESE SOCKETS HAVE .50" LEADS. JUST A LITTLE SHORTER THAN THAN THE STANDARD 3 LEVEL WIRE WRAP SOCKETS WITH .67" LEADS.

	1-99	100-UP
8 PIN WW-2	.40	.35
14 PIN WW-2	.45	.39
16 PIN WW-2	.45	.39
20 PIN WW-2	.75	.59
22 PIN WW-2	.50	.39
24 PIN WW-2	.89	.75
28 PIN WW-2	.89	.75
40 PIN WW-2	.99	.89

SPECIALS END 1/31/85

RF MODULATOR

(ASTEC UM1082)

QUANTITIES LIMITED

- PRESET TO CHANNEL 3
- USE TO BUILD TV-COMPUTER INTERFACE
- +5 VOLT OPERATION

$6.95

5V / AUDIO / RF OUT / GROUND

EMI FILTER

- MAJOR MANUFACTURER
- LOW COST
- FITS LC-HP BELOW



$4.95

LINE CORDS

LC-2	2 CONDUCTOR	6 ft	.39
LC-3	3 CONDUCTOR	6 ft	.99
LC-HP	3 CONDUCTOR WITH STANDARD FEMALE SOCKET	6 ft	1.49
LC-CIR	CIGARETTE LIGHTER PLUG WITH 6 ft COILED CORD		2.95

MUFFIN FANS

4.68" SQUARE	14.95
3" SQUARE	14.95

RESISTORS

¼ WATT 5% CARBON FILM
ALL STANDARD VALUES
FROM 1 OHM TO 10 MEG OHM

50 PIECES SAME VALUE	.025
100 PIECES SAME VALUE	.02
1000 PIECES SAME VALUE	.015

CAPACITORS

TANTALUM

1.0µf	15V	.40	.47µf	35V	.50
6.8	15V	.70	1.0	35V	.45
10	15V	.80	2.2	35V	.65
22	15V	1.35	4.7	35V	.85
.22	35V	.40	10	35V	1.00

DISC

10pf	50V	.05	560	50V	.05
22	50V	.05	680	50V	.05
25	50V	.05	820	50V	.05
27	50V	.05	.001µf	50V	.05
33	50V	.05	.0015	50V	.05
47	50V	.05	.0022	50V	.05
56	50V	.05	.005	50V	.05
68	50V	.05	.01	50V	.07
82	50V	.05	.02	50V	.07
100	50V	.05	.05	50V	.07
220	50V	.05	.1	12V	.10

MONOLITHIC

.01µf	50V	.14	.1µf	50V	.18
.047µf	50V	.15	.47µf	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
1µf	25V	.14	1µf	50V	.14
2.2	35V	.15	4.7	16V	.14
4.7	50V	.15	10	16V	.14
10	50V	.15	10	50V	.16
47	35V	.18	22	16V	.14
100	16V	.18	47	50V	.20
220	35V	.20	100	15V	.20
470	25V	.30	100	35V	.25
2200	16V	.60	220	25V	.30
			330	16V	.40
			550	16V	.42
			1000	16V	.60
			2200	16V	.70
			6000	16V	.85

COMPUTER GRADE

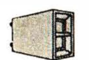
44,000µf 30V 3.95

HARD TO FIND "SNAPABLE" HEADERS

Can easily be snapped apart to make any size header, all with .1" centers

1x36	STRAIGHT LEAD	.99
2x40	STRAIGHT LEAD	2.49
2x40	RIGHT ANGLE	2.99

SHORTING BLOCKS



SPACED AT .1" CENTERS
IDEAL FOR DISK DRIVES
OR ANY .1" HEADER

5/1.00

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95
10 POSITION	1.29

EDGECARD CONNECTORS

S-100 ST	S-100	3.95
S-100 WW	S-100	4.95
72 PIN ST		6.95
72 PIN WW		7.95
62 PIN ST	IBM PC	4.95
50 PIN ST	APPLE	4.95
44 PIN ST		2.95
44 PIN WW		4.95

BYPASS CAPS

.01 µf DISC	100/$6.00
.01 µf MONOLITHIC	100/$12.00
.1 µf DISC	100/$8.00
.1 µf MONOLITHIC	100/$15.00

DIODES

1N751	5.1 VOLT ZENER	.25
1N759	12.0 VOLT ZENER	.25
1N4148	(1N914)SWITCHING	25/1.00
1N4001	50PIV 1A	12/1.00
1N4004	400PIV RECTIFIER	10/1.00
1N5402	200PIV 3A	.25
KBP02	200PIV 1.5A BRIDGE	.45
KBP04	400PIV 1.5A BRIDGE	.55
MDA801	50PIV 12A BRIDGE	1.39
MDA980-1	50PIV 12A BRIDGE	1.95
MDA980-2	100PIV 12A BRIDGE	2.25
VM48	DIP-BRIDGE	.35

36 PIN CENTRONICS

IDCEN36	RIBBON CABLE MALE	8.95
IDCEN36/F	RIBBON CABLE FEMALE	8.95
CEN36	SOLDER CUP MALE	7.95

LED DISPLAYS

HP5082-7760	CC	.43"	1.29
MAN-72	CA	.3"	.99
MAN-74	CC	.3"	.99
FND-537(359)	CC	.375"	1.25
FND-500(503)	CC	.5"	1.49
FND-507(510)	CA	.5"	1.49
TIL-311 4x7 HEX W/LOGIC		.270"	9.95

DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS								
		8	14	16	18	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	AUGATxxST	.99	.99	.99	1.69	1.89	1.89	1.99	2.49	2.99
HIGH RELIABILITY TOOLED WW IC SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIES (DIP HEADERS)	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	---	.95	.95	---	---	---	1.75	---	2.95

FOR ORDERING INSTRUCTIONS SEE IDC CONNECTORS BELOW

HEAT SINKS

TO-220	SCREW ON	.35
TO-220	CLIP ON	.35
TO-3	SCREW ON	.95
TO-220	INSULATOR	10/1.00
TO-3	INSULATOR	10/1.00

SWITCHES

SPOT	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O.	.39
SPST	MINI-PUSHBUTTON N.C.	.39
BCD OUT	10 POSITION 6 PIN DIP	1.95

DIFFUSED LEDS

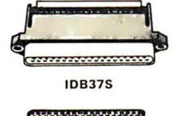
		1-99	100-up
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.18	.15
JUMBO YELLOW	T1¾	.18	.15
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09
MINI GREEN	T1	.18	.15
MINI YELLOW	T1	.18	.15
RECT RED	2x5mm	.25	.22
RECT GREEN	2x5mm	.30	.27
RECT YELLOW	2x5mm	.30	.27

D-SUBMINIATURE

DESCRIPTION		ORDER BY	CONTACTS				
			9	15	25	37	50
SOLDER CUP	MALE	DBxxP	1.19	1.59	1.90	2.85	4.25
	FEMALE	DBxxS	1.50	1.85	2.25	3.90	5.25
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	1.65	2.20	3.00	4.83	---
	FEMALE	DBxxSR	2.18	3.03	3.00	6.19	---
WIRE WRAP	MALE	DBxxPWW	1.69	2.56	3.89	5.60	---
	FEMALE	DBxxSWW	2.76	4.27	6.84	9.95	---
IDC RIBBON CABLE	MALE	IDBxxP	2.95	3.90	4.75	6.95	---
	FEMALE	IDBxxS	3.25	4.29	5.25	7.95	---
HOODS	BLACK	HOOD-B	---	---	.99	---	---
	GREY	HOOD	.89	.99	.99	1.09	1.19

MOUNTING HARDWARE-$1.00

FOR ORDERING INSTRUCTIONS SEE IDC CONNECTORS BELOW



IDB37S



DB37S

DB25SR

TEXTOOL ZERO INSERTION FORCE SOCKETS AND RECEPTACLES





SCREWDRIVER CLAMP
ECONO ZIF



LEVER CLAMP
ZIF SOCKET

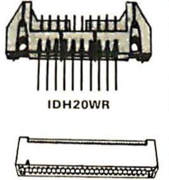
WW RECEPTACLES
ZIF RECEPTACLE

TYPE	CONTACTS				
	14	16	24	28	40
ECONO ZIF	---	4.95	6.75	7.75	9.95
ZIF SOCKET	4.95	4.95	5.95	6.95	9.95
ZIF RECEPTACLE	8.25	8.75	9.75	10.50	12.75

IDC CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS					
		10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WW HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WW HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.79	.99	1.39	1.59	1.99	2.25
RIBBON HEADER	IDMxx	---	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	1.75	2.25	2.65	2.75	3.80	3.95

ORDERING INSTUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE: A 10 PIN RIGHT ANGLE HOLDER STYLE WOULD BE IDH10SR



IDH20WR

IDE50

RIBBON CABLE

CONTACTS	SINGLE COLOR		COLOR CODED	
	1'	10'	1'	10'
10	.18	1.60	.83	7.30
16	.28	2.50	1.00	8.80
20	.36	3.20	1.25	11.00
25	.45	4.00	1.32	11.60
26	.46	4.10	1.32	11.60
34	.61	5.40	1.65	14.50
40	.72	6.40	1.92	16.80
50	.89	7.50	2.50	22.00

JDR Microdevices

1224 S. Bascom Avenue, San Jose, CA 95128
800-538-5000 • 800-662-6279 (CA) • (408) 995-5430
FAX (408) 275-8415 • Telex 171-110

RETAIL STORE - 1256 S. BASCOM AVENUE
HOURS: M-W-F, 9-5   TU-TH, 9-9   SAT, 10-3

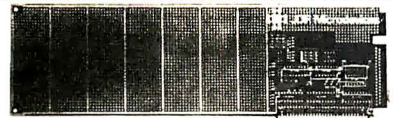
PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDERING

TERMS: Minimum order $10.00. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges - please contact our sales department for the amount. CA. residents must include 6% sales tax. Bay Area and LA residents include 6½%. All merchandise is warranted for 90 days unless otherwise stated. Prices are subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.

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P500-3	HORIZONTAL BUS	$22.75
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P441-4	SINGLE FOIL PADS 4.5" x 6.0"	$14.20
P442-1	BARE - NO FOIL PADS 4.5" x 9.0"	$10.40
P442-3	VERTICAL BUS 4.5" x 9.0"	$14.20
P442-4	SINGLE FOIL PADS 4.5" x 9.0"	$13.50

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P721-3	VERTICAL BUS 4.5" x 6.0"	$13.25
P721-4	SINGLE FOIL PADS 4.5" x 6.0"	$14.20
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P722-3	VERTICAL BUS 4.5" x 9.0"	$14.20
P722-4	SINGLE FOIL PADS 4.5" x 9.0"	$15.15

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SHUGART

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SA 460	5¼" (80 TRACK) DS/QUAD	$199.95

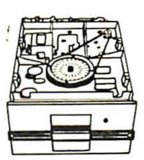
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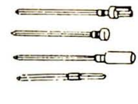
BW-630

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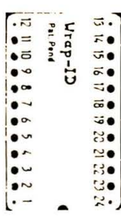
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3	1.60	4.70	8.20
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4	1.75	5.40	9.60
4.5	1.80	5.75	10.30
5	1.85	6.10	11.00
5.5	1.90	6.50	11.75
6	2.00	6.85	12.50
6.5	2.30	7.80	14.30
7	2.40	8.20	15.05
7.5	2.50	8.55	15.85
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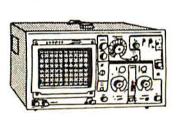
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20 MHz DUAL TRACE OSCILLOSCOPE

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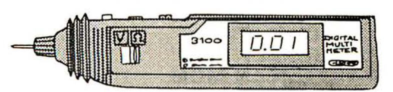
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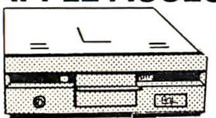
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Parallel Port	1	1
Clock Calendar	YES	YES
Game Adaptor	Optional	Optional

[1] with optional 128K MAXISTACK
[2] second serial port optional

OPTIONS:

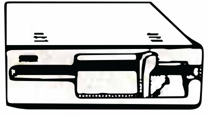
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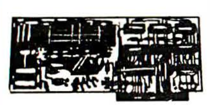
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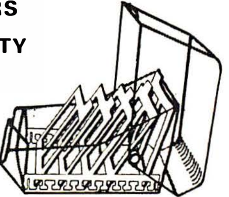
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DOUBLE SIDED, DOUBLE DENSITY
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WANTED: Nonprofit college seeks tax-deductible donations of computers, printers, and terminals. Certified receipts available. Colorado Baptist College, 11111 East Mississippi Ave., Aurora, CO 80012, (303) 363-0937.

NEEDED: 256K IBM PC or compatible, terminal, monitor, disk drive, printer, related hardware. Tax-deductible donation for CAI by beginning sociology students. Shipping reimbursed. Dr. Douglas L. White, Computers in the Sociology Classroom Project, 307 Reuther Bldg., Henry Ford Community College, Dearborn, MI 48128.

WANTED: The Poetry Resource Center of Michigan, a nonprofit, tax-exempt organization serving the literary community of Michigan, needs donations of IBM or plug-compatible equipment for word processing, record keeping, and office management. Yonah Karp, PRC, 621 South Washington Ave., Royal Oak, MI 48067, (313) 399-3163/865-8513.

WANTED: Nondenominational Christian church seeks donation of microcomputer and peripherals for use in Christian school and church administration. Will pay shipping and give receipt. Glen Gardeski, 233 Lansing St., Utica, NY 13501, (315) 724-0219.

WANTED: Graduate student in exhibit on history of calculating devices needs anything in hardware representative of early computer generations, paper tape, punch cards, slide rules, pictures, etc. Project unfunded, but willing to pay shipping and discuss small payment for some items. Donated items will be credited. Roger Wallace, 2360 Grandview Terrace, Manhattan, KS 66502.

WANTED: Graduate with knowledge of COBOL, FORTRAN, BASIC, etc. and programming experience in system and application software seeks correspondents. Worked on file management utilities, text editor, spooler, report utility. Developed in C BASIC (order/invoice/sales/inventory/payroll systems). Stellus Pereira, Jeffrin Cottage, Opp I.I.T. Main Gate, Powai, Bombay 400 076, India.

NEEDED: Inexpensive, used, or unwanted material relating to Z80 and 68000 programming. I've built a homebrew that needs an assembler and improved operating system. Any public-domain subroutines or algorithms printed on paper only would be appreciated. Michael Sanders, #228183, Wynne 12T, Huntsville, TX 77349.

NEEDED: Seminary graduate turned software engineer (cowrote Tandy's ALDS), beginning CHARIS Christian videotex service, seeks equipment (exchanged for free advertising) and technical expertise in starting this ministry to churches. For free brochure, send SASE. Christian Helps and Resources Information Service, Attn: Larry West, POB 79635, Saginaw, TX 76179-0635.

FOR SALE: Ohio Scientific Inc. hardware. Get on our mailing list. Walt Thomas, RD #1, Box 135, Linden, PA 17744, (717) 398-1893.

WANTED: Electronics engineering student needs contributions of electronics/computer books, magazines, training kits, or equipment. Donation of Apple peripherals, especially a disk drive, most welcome. James Y. Kwan, Room 307, Third Floor, 1109 Severino Reyes St., Santa Cruz, Manila, 2805, Philippines.

WANTED: BYTE 1975–1982. *Softalk* No. 1 through September 1982. *Nibble* No. 1–Vol. 2, No. 8 and Vol. 4, No. 7. Junichiro Kida, 1566-220, Nara-cho, Midori-ku, Yokohama 227, Japan.

FOR SALE: Micropolis SS/DD 5¼-inch disk drive, Model 1021-2: $150. Micropolis S-100-bus disk-controller board, Model 107: $160. Includes manuals. J. Tyler, Robert Gordon's Institute of Technology, School of Mathematical Sciences and Computer Studies, St. Andrew St., Aberdeen, Scotland AB1 1HG, U.K., 0224 633611 ext. 462.

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FOR SALE: Commodore 64 Executive portable. Built-in disk drive and color monitor, modem, joystick, and KoalaPad: $950. P. D. Bailey, 203 Willow Way, Vicksburg, MS 39180, (601) 634-2824.

FOR SALE: Paper Tiger 440 printer plus parallel interface card. Includes all information, cables, and ribbons, excellent condition: $300 or best offer. Dr. R. E. Crowder, 460 North Terrace Dr., Wichita, KS 67208, (316) 684-5184.

WANTED: Epson QX-10 system, Hayes 300/1200-bps modem, and stand-alone hard disks for our users group's RBBS systems. Fellow QXers are welcome to send SASE for a sample newsletter. EUG, Box 1076, Lemont, PA 16851, (814) 237-5511.

FOR SALE: Eagle monochrome monitor and color card in mint condition; fully compatible with IBM monochrome monitor and color card. List price over $600; asking $400. Kenneth Tam, 68 East Broadway, New York, NY 10002, (212) 226-6248 after 6 p.m.

FOR SALE: Brand new Tandon TM848-1E and −2E OEM 8-inch drive service manual in factory binder: $25 plus postage or best offer. Bill Weinel, 139 Pineland Circle, Raleigh, NC 27606, (919) 851-1270.

FOR SALE: HP 82905B dot-matrix printer (Opt 248), the HPIL version for use with HP 41, HP 75, or HP 71B. New $795; will sell for $350. John Gilby, Site 11, Compartment 175, RR #3, Sydney, Nova Scotia B1P 6G5, Canada.

FOR SALE: Apple dot-matrix printer used for only four months, excellent condition: $280 negotiable. Joe Genduso, College Station, Lafayette College, POB 4391, Easton, PA 18042.

FOR SALE: First 16 issues of BYTE. Send SASE and reasonable offer. Henry Shaw, POB 275, Cape May Point, NJ 08212.

FOR SALE: Public-domain interactive structured Z80 assembly-language compiler and screen editor. Steve Allen, 5016 48th SW, Seattle, WA 98136.

FOR SALE: Tandon TM-100-2 double-sided, 5¼-inch drive, never used: $190. Fred Orkin, 630 South Bowman Ave., Merion Station, PA 19066, (215) 448-7960.

WANTED: Altair S-100 case with motherboard and power supply—just the box. Looks are unimportant. Gerald Henrici, 11 Varick St. #5M, New York, NY 10013, (212) 966-0410 days, (212) 966-4499 evenings.

FOR SALE: *Kilobaud* No. 1–53, except No. 48. All in good condition: $100 plus shipping or best offer. Thomas Aulicino, 2014 59th St., Brooklyn, NY 11204.

FOR SALE: OSI C8PDF 48K static RAM with video board to interface with TV. Has tone generator with color/graphics capabilities, and includes modem and RF interface: $2200 or best offer. I will pay shipping. M. Chew, POB 32372, Pensacola, FL 32514.

FOR TRADE: PC1401 programs I developed for ham radio, navigation, electronics, statistics, and memos. Exchange on noncommercial basis. Goetz Kluge, Meisenweg 16, 8011 Vaterstetten, West Germany.

FOR SALE: New S-100 12-slot motherboard, power supply, and cabinet by XOR, two 8-inch Siemens FDD 100-8 floppy-disk drives: $550. Amber monitor (Zenith ZVM-122): $85. Ken Skelps, 39 Holly Ave., Shalimar, FL 32579, (904) 651-5826.

FOR SALE: A Bell Data 2400-bps type modem with serial inputs, power input, 2400/1200/300 switchable data rates, originate, answer, auto-answer, full/half-duplex, synchronous or asynchronous. Worth $3200; sell for $1200. Lyle Jackson, 1120 Pine Hill Rd., McLean, VA 22101, (703) 356-5215.

WANTED: Single-sheet feeder for NEC 5530 printer. Gregory Grover, 3558 Mandeville Canyon Rd., Los Angeles, CA 90049.

FOR SALE: S-100 computer system, IMSAI 8080 computer, 20-slot motherboard, 64K RAM, four SIO ports, disk controller, front panel card, cabinet, power supply, two ICOM disk drives, Hazeltine Espirit I terminal, and documentation: $1500 or best offer. R. L. Dalzell, c/44th Signal BN, APO NY 09175, (Federal Republic of Germany) 6151-68315.

WANTED: Technical information for TI 99/4A, interfacing information, schematics, etc. Also, used HP 41cv calculator. Joseph Walker, Rt. 3, Box 287, Ruston, LA 71270.

WANTED: Users/owners/operators, I'm starting an international bulletin-board system listing; if interested, please send description of your BBS and phone number. Moore & Co., 301 Nottingham Dr., Brick Town, NJ 08724.

FOR SALE: Brand new green DEC Rainbow 100 monitor: $275. Joyce Goodrich, 315 East 68th St., New York, NY 10021, (212) 879-9771.

WANTED: High school student needs IBM PC-compatible equipment: disk drives, disk controller, video controller, monitor, keyboard, power supply, and case. Donations or discounts welcome; I will pay postage. Daniel Miller, 6349 County Rd. 11A, Garrett, IN 46738, (219) 357-3710.

WANTED: College student seeks donation of hardware and software documentation for the HP 3000. Also, a terminal for timesharing on the HP 3000. I will pay shipping. Christopher M. Heim, 6431 Valley Hi Dr., Sacramento, CA 95823, (916) 456-3661.

WANTED: Telecomputer for telemarketing. Unit is a dedicated microprocessor with two tape decks. Automatically dials every tenth number in a telephone exchange and dials numbers preprogrammed into memory. Capable 50 calls per hour. Give manufacturer's name, when bought, condition, and your price. Art Rein, 32 New York Ave., Freeport, NY 11520, (516) 379-6421.

WANTED: High school student needs donated computers and peripherals to pursue career in programming or electronics. Apples, TRS-80s, Zeniths, S-100, or CP/M preferred. Will pay postage. Scott Lawler, 1700 Tampico Court, Petaluma, CA 94952.

FOR SALE: Tandon CDC 5¼-inch SS/DD disk drives. Limited quantity of used B: drives in excellent condition: $75. Larry Furman, 81 Holly Ave., Staten Island, NY 10308, (718) 317-6803.

FOR SALE: DEC PRO-350, 512K, P/OS, DCL, and LA50 printer: $4500 or best offer. Mike Saltz, 606 El Redondo, Redondo Beach, CA 90277, (213) 379-0891.

FOR SALE: BYTE July 1976–June 1981. Book *Best of BYTE #1*. *Kilobaud* September 1977–September 1981 (except October 1977, January, February, and May 1978). *Dr. Dobbs Journal* February 1977–January 1981. Mark Tait, 5395 Burford St., San Diego, CA 92111.

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B·O·M·B

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19	401	BYTE U.K.: The Amstrad CPC 464	Pountain
20	415	BYTE West Coast: Light Touches	Markoff, Robinson
21	429	BYTE Japan: The New and the Old	Raike

PC AT Preview Wins

The product description of "The IBM PC AT," compiled by BYTE staff members Rich Malloy, G. Michael Vose, Tom Clune, and George Bond, is the winning article in the October BYTE. Steve Ciarcia's "An Ultrasonic Ranging System" wins second-place mention. Computing at Chaos Manor encountered only "Minor Problems" this month and wins Jerry Pournelle third place. "Database Types" by Rich Krajewski is fourth. And fifth in the winning lineup is "Generating and Testing Pseudorandom Numbers" written by Charles A. Whitney. Mr. Whitney is also the winner of the first-place award of $100, for his was the first non-staff-written article that placed in the top five. Therefore, the winner of the second-place award of $50 is actually sixth in the lineup: Edward A. Rothchild, author of "Optical Memory: Data Storage by Laser." Congratulations, gentlemen.

R·E·A·D·E·R S·E·R·V·I·C·E

TO GET FURTHER information on the products advertised in BYTE, either pick up your touch-tone telephone and use AIMS or fill out the reader service card. Either way full instructions are provided following this reader service index which is provided as an additional service by the publisher, who assumes no liability for errors or omissions. *Correspond directly with company.

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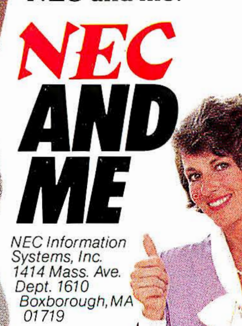
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